United States
Department of
Agriculture

Forest Service

**Forest
Health
Protection**

December 1997

Forest Insect and Disease Conditions in the United States 1996

Healthy Forests Make
A World of Difference

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PREFACE

This is the 46th annual report prepared by the U.S. Department of Agriculture, Forest Service, of the insect and disease conditions of the Nation's forests. This report responds to direction in the Cooperative Forestry Assistance Act of 1978, as amended, to conduct surveys and report annually on insect and disease conditions on all forests of the United States. Included in the report are the insect and disease conditions of major national significance in 1996. Insect and disease conditions of local importance are reported in regional and state reports.

The report describes the extent and nature of insect and disease-caused damage of national significance in 1996. As in the past, selected insect and disease conditions are highlighted in the front section of the report. Maps are provided for some pests showing affected counties in the East and affected areas in the West. Graphs are provided for some pests showing acreage trends over the last several years. Also provided are tables showing acreages affected for selected pests by state by year for the last five years.

The second section of the report brings together insect, disease, and abiotic agent damage from each affected region under the organism's or agent's name. The organisms and agents are arranged alphabetically in the appropriate section:

- insects—native;
- insects—nonnative;
- diseases—native;
- diseases—nonnative;
- diseases—origin unknown;
- declines and complexes;
- seed orchard insects and diseases;
- nursery insects and diseases; and
- abiotic damage.

These categories are listed in the table of contents; there is no index.

The information in this report is provided by the Federal/State Cooperative Forest Health Protection Program of the USDA Forest Service. This program serves all Federal lands, including the National Forest System and the lands administered by the Departments of Defense and the Interior. Service is also provided to Tribal lands. The program also provides assistance to private landowners through the State Foresters. A key part of the program is detecting and reporting insect and disease epidemics and the effects of wind, air pollution, floods, droughts, and other agents. Detection surveys are conducted on a regular basis by State and Forest Service program specialists.

For additional information about conditions, contact the Forest Service regional office listed on the next page (see map for office coverage) or your State Forester.

The Forest Service also prepared a report "America's Forests: 1997 Health Update" that highlights major forest health concerns. The report is available on the internet. The report discusses the changing ecological conditions in the Intermountain West, East, South, and Alaska. The report also deals with exotic (nonnative) pests, the rural-urban-wildland interface, and the effects of weather and air pollution on forests.

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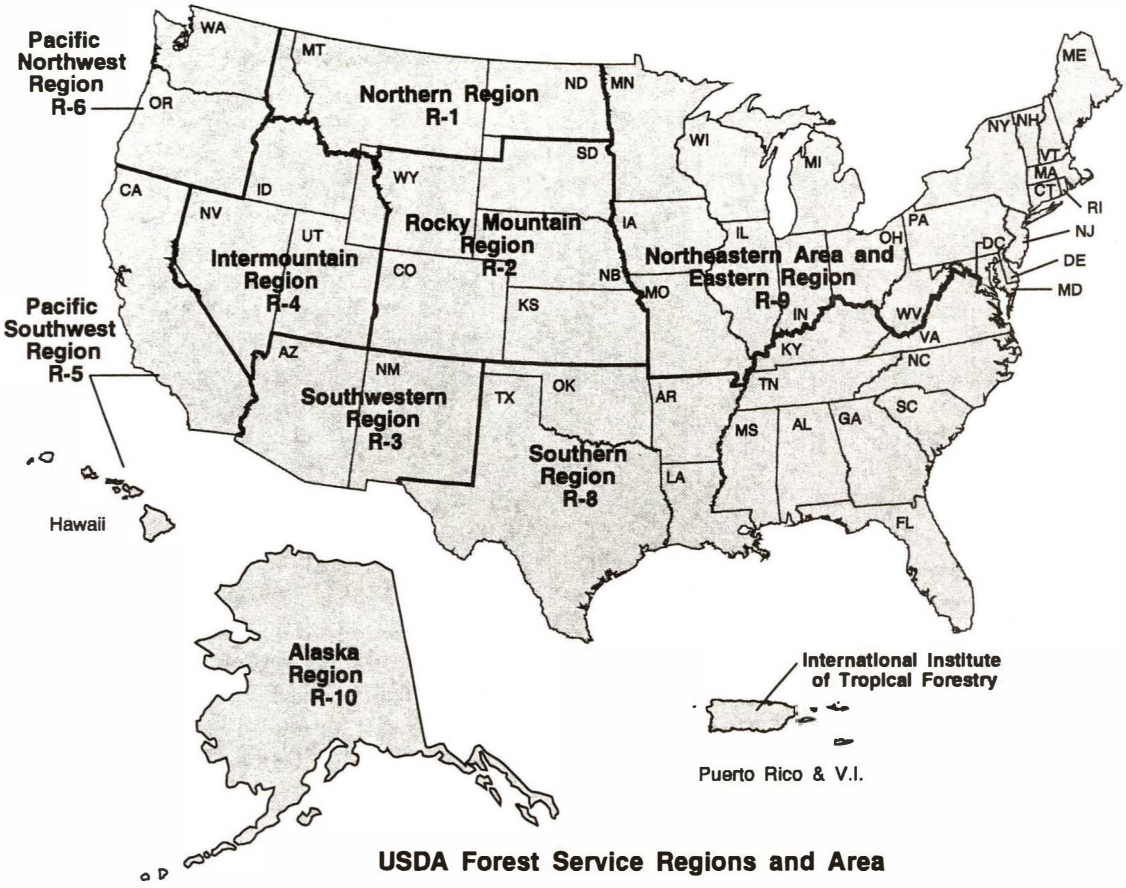

USDA Forest Service Regions and Area

Copies of this report are available from
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CONTENTS

EXECUTIVE SUMMARY

Introduction

About one-third of the Nation's land area, 736.7 million acres, is forested; 380.3 million acres in the East and 356.4 million acres in the West. Nationwide, these forests provide economic, social, and environmental benefits. Native and nonnative (exotic) insects and diseases as well as abiotic influences all effect the health and productivity of the forests.

Highlighted below, and in part 1 of this report, are some of the major native insects and diseases of concern. Also highlighted are some nonnative insects and diseases that have been introduced into the United States. These pests either are causing serious damage or have the potential to do so.

Insects: Native

Southern pine beetle–affected acreage decreased from 21.7 million acres in 1995 to 7.3 million acres in 1996.

Mountain pine beetle–affected acreage decreased from 575.5 thousand acres in 1995 to 300,000 acres in 1996.

Spruce budworm defoliated 235.9 acres of trees in Alaska and 207.6 acres of trees in Minnesota in 1996. New infestations were found in Michigan on Isle Royale and in Pennsylvania.

Western spruce budworm defoliation continues at less than half a million acres for the fifth consecutive year.

Spruce beetle infestations in Alaska reached the highest level in history in 1996—1.1 million acres of active and newly infested acres. Spruce beetle activity was low in the West except in Utah and Washington.

Insects: Nonnative

Asian long-horned beetle was discovered in September 1996, in Brooklyn and Amityville sections of Long Island, New York. A quarantine was initiated restricting movement of host materials. Eradication treatments are underway.

Balsam woolly adelgid was introduced into North America in 1908. In 1996 trees were killed on 37,700 acres in the Northwest and 64,700 acres in the southeast.

Gypsy moth (European)-caused defoliation decreased from 1.4 million acres in 1995 to 200 thousand acres in 1996. Suppression projects were carried out in eight States. Eradication projects were conducted in eight States outside the generally infested area. Moths are being caught in traps in several western states.

Gypsy moth (Asian) was accidentally introduced into North Carolina in 1993. The infestation appears to to be eradicated; trapping continues in 1997.

Common European pine shoot beetle was discovered in 1992 in Ohio. The beetle was found in Maryland and West Virginia for the first time in 1995, bringing the total number of States to eight. The beetle was found in 65 additional counties within the infested States in 1996. State and Federal quarantines are in force.

Hemlock woolly adelgid was introduced into Virginia in 1950 and has spread north into southern New England. The insect was found in North Carolina for the first time in 1995. Adelgids were found in two additional North Carolina counties in 1996.

Diseases: Native

Fusiform rust is the most damaging disease of pines in the South, affecting an estimated 13.4 million acres of pines.

Dwarf mistletoes, native parasitic plants that grow on conifers, are the most serious disease of trees in the West. An estimated 28.9 million acres of conifers are infected.

Diseases: Nonnative

White pine blister rust, introduced around the turn of the century, now occurs throughout most of the ranges of the five-needled pines, including eastern white pine, western white pine, sugar pine, and high-elevation whitebark pine causing extensive tree mortality. In 1990, blister rust was found in New Mexico and is threatening the viability of southwestern white pine.

Beech bark disease is the result of an attack by the beech scale followed by invasion of a fungus. The scale was introduced into North America about 1890. The disease is found killing beech trees from Maine to Pennsylvania, with outlying spots in West Virginia, North Carolina, and Tennessee.

Diseases: Origin Unknown

Dogwood anthracnose, first found in 1970's, is now found in 21 eastern states, as well as Washington, Oregon, and Idaho. The disease kills both woodland and ornamental dogwoods.

Butternut canker is found throughout the range of butternut. Trees exhibiting resistance are being propagated for study.

Conditions by Agent

Part 2 of this report provides more detailed information about these insects and diseases as well as others. The report also describes abiotic factors, such as wind and drought, that damage forests. Abiotic factors often predispose the trees to insect and disease buildups.

Part 1 National Highlights

Highlights

Forested Areas*

About one-third of the Nation's land area, 736.7 million acres, is forested; this acreage includes Alaska. Of this forested acreage, 380.3 million acres (52 percent) are in the East, 227.3 million acres (31 percent) are in the Continental West, and 129.1 million acres (17 percent) are in Alaska. By ownership nationwide, 42 percent of the acreage is in public ownership and 58 percent in private ownership. Of the public ownership, 20 percent is in the East, 48 percent in the Continental West and 32 percent in Alaska. In contrast, 75 percent of the private ownership is in the East, 18 percent in the Continental West, and 7 percent in Alaska.

Eastern hardwood forests make up 74 percent of all of the forested acreage in the East. The largest component of the eastern hardwood forest type is oak-hickory, which occupies 130 million acres or 34 percent of the eastern forested acreage and is found through out the South and southern half of the North.

The maple-beech-birch forests occur on 51 million acres or 13 percent of the eastern forest and are located in the North.

The oak-pine forests occupy 32 million acres or 8 percent of the eastern forested acreage and are located in the South, as are the oak-gum-cypress forests, which occur on 29 million acres or 8 percent of the eastern forested acreage.

The aspen-birch forests occupy 17 million acres or 4 percent of the eastern forested acreage and are located in the North. The elm-ash-cottonwood forests on 15 million acres or 4 percent of the forested acreage are bottom land forests in both the North and South. Other forest types occupy 13 million acres or 3 percent of the forested acreage in the East.

Eastern softwood forests make up the remaining 26 percent of the eastern forested acreage. The loblolly-shortleaf pine forests occupy 50 million acres or 13 percent of the eastern forested acreage and occur in the South. Also in the South are the longleaf-slash pine forests, which cover 14 million acres or 4 percent of the forested lands.

The spruce-fir forests are on 20 million acres or 5 percent of the forested lands and the white-red-jack pine forests on 15 million acres or 4 percent of the forested lands; both are in the North.

Western hardwood forests occupy 49 million acres, or 14 percent of the western forested acreage, including that in Alaska. The primary species are oaks in California, aspen in the Intermountain region, and red alder in the Pacific Northwest.

Western softwood forests make up 86 percent of all of the western forests. Douglas-fir forests occupy 43 million acres or 12 percent of the western forest lands. Douglas-fir is found throughout much of the West except Alaska.

Ponderosa pine forests occupy 31 million acres or 9 percent of the forested acreage; the species is present through much of the West. Lodgepole pine is also found throughout much of the West but is most abundant in the Intermountain region, occupying 18 million acres or 5 percent of the forested acreage.

Hemlock-sitka spruce forests are found on the Pacific Slope in Oregon and Washington and along coastal Alaska. These forests occupy 16 million acres or 5 percent of the forested lands. The fir-spruce forests occupy 60 million acres or 17 percent of the acreage and are mid-to-higher elevation forests throughout the West.

The other softwoods group is made up primarily of black spruce stands in interior Alaska and occupies 70 million acres or 20 percent of the forested land in the West.

The pinyon-juniper type occupies 48 million acres or 14 percent of the forested acreage.

Other western types (western white pine, larch, redwood, chaparral, and nonstocked areas) occupy 17 million acres or 5 percent of the western forested acreage.

*Data may not add to totals because of rounding

From: Powell, Douglas S.; Faulkner, Joanne L,; Darr, David R.; Zhu, Zhiliang; MacCleery, Douglas W. 1993. Forest resources of the United States, 1992. General Technical Report RM-234. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experimenyt Station. 132p.+ map. [Revised, June 1994]

Exotic Insects and Diseases

The single greatest threat to the integrity and viability of forest ecosystems is the introduction of exotic (nonnative) species. We need only to look at the period from 1860 to the present to see the serious consequences of introducing pests into North America. With increased international trade, there is the distinct possibility of more frequent introductions in the future.

Asian long-horned beetle (*Anoplophora glabripennis*) was discovered in 1996 in Brooklyn and Amityville, New York. If this insect becomes established in North America, severe consequences could be experienced by the maple sugar and tourist industries in New York, New England, and elsewhere. Eradication work begins early in 1997.

Balsam woolly adelgid (*Adelges piceae*) was first found in Brunswick, Maine, in 1968 and has spread into the Maritime Provinces of Canada and the northeastern United States. The adelgid was found in the southern Appalachians and the Pacific Northwest in the 1950's.

Common European pine shoot beetle (*Tomicus piniperda*) was found near Cleveland, Ohio, in 1992 and is now found in seven neighboring States. The beetle is a threat to Christmas tree production.

Gypsy moth (Asian form) (*Lymantria dispar*) was accidentally introduced to the West Coast (Oregon and Washington) onboard cargo ships arriving from the Russian Far East in 1991. The moth was also introduced to the East Coast (North Carolina) in 1993 onboard a cargo ship loaded with military equipment returning from Germany. Eradication projects have been successful.

Gypsy moth (European form) (*Lymantria dispar*) was intentionally brought to America from France in 1869 to start a silk industry. The moth escaped and has gradually spread throughout the East from Maine to Virginia and Wisconsin. Isolated infestations are frequently found elsewhere in the South and West.

Hemlock woolly adelgid (*Adeleges tsugae*) was introduced into the West Coast from Asia in 1924; and is found in British Columbia, Washington, Oregon, and California. The adelgid was found near Richmond, Virginia, in 1950, and has spread north to southern New England. The adelgid is a threat to the survival of Eastern and Carolina hemlocks.

Larch sawfly (*Pristiphora erichsonii*) was first reported in 1880 at the Arnold Arboretum near Boston, Massachusetts. Between 1880 and 1910 sawfly outbreaks were generally widespread throughout the range of tamarack (*Larix laricina*) which extends west to Minnesota and Saskatchewan. The sawfly was found in Montana in 1935 and Oregon in 1964. By 1965 the sawfly had reached outlying tamarack stands in Alaska.

Spruce aphid (*Elatobium abietinum*) was introduced into the West Coast from Europe prior to 1953. The aphid had been reported from Alaska to California in the 1970's. This 1996 report chronicles the finding of the spruce aphid in Arizona in 1988 and New Mexico in 1989, and describes the current outbreak on over 10 thousand acres in Arizona.

Beech bark disease results when bark, attacked and altered by the beech scale, *Cryptococcus fagisuga*, is invaded and killed by a fungus, *Nectria coccinea* var *faginata*. The scale was accidentally brought to Nova Scotia, Canada, about 1890. By 1932 the scale and associated fungus were killing trees in the Maritime Provinces, Maine, and Massachusetts. It is now found in West Virginia, and on the North Carolina and Tennessee border.

Chestnut blight (*Cryphonectria parasitica*) was discovered in the New York Zoological Park in 1904. It is believed to have been brought into North America on Asiatic chestnut planting stock. In less than 50 years the disease swept throughout the natural range of the American chestnut tree, converting the chestnut-oak forests to oak-hickory forests.

Dutch elm disease (*Ophiostoma ulmi*) was discovered in Ohio in 1930. The fungus entered the United States from Europe on elm burl logs. Early infestations were around sea ports, veneer mills, and railroad yards. American elm is no longer a major urban shade tree.

White pine blister rust (*Cronartum ribicola*) is an introduced fungus that was first found in New York in 1906, arriving on white pine nursery stock from Germany. The disease has spread throughout the range of eastern white pine. The disease was also introduced into western North America, arriving on white pine nursery stock imported from France; it was first found in British Columbia in 1921. The disease has spread throughout much of the West, affecting western white pine, sugar pine, and high-elevation five-needle pines, causing significant tree mortality. In 1990, the disease was found affecting southwestern white pine in New Mexico.

Partial List of Exotic Pests Introduced Into North America

Organism	General origin	Year of introduction	Site of introduction
Gypsy moth (European form)	France	1869	Boston, MA
Larch sawfly	Eurasia	1880	Boston, MA
Beech bark disease	Europe	1890	Nova Scotia
Chestnut blight	Asia	1904	New York
White pine blister rust	Germany France	1906 1921	New York British Columbia
Balsam woolly adelgid	Europe	1908	Brunswick, ME
Hemlock woolly adelgid	Asia	1924 1950	West Coast Richmond, VA
Dutch elm disease	Europe	1930	Ohio
Spruce aphid	Europe	prior to 1953	West Coast
Gypsy moth (Asian form)	Russia Europe/Asia	1991 1993	Oregon & Washington North Carolina
Common European pine shoot beetle	Europe	prior to 1992	Ohio
Asian long-horned beetle	Asia	prior to 1996	New York

Insect Conditions Highlights

Gypsy moth

European form

Lymantria dispar was introduced into Massachusetts in 1869 and continues to spread to the south and west. Currently all or parts of 16 states from New England to North Carolina, West Virginia, Ohio and Michigan are considered generally infested. Wisconsin reported trapping 98,000 moths but observed no defoliation. Single and small groups of moths were caught in traps in several States across the West. The largest catch, by far, was 173 moths caught in traps in Washington.

Defoliation in the East decreased from 1.4 million acres 1995 to 200,000 acres in 1996. The fungal pathogen *Entomophaga maimaiga* caused wide spread collapse of the populations in some areas. Of the 200,000 acres, 60 percent were in Ohio and West Virginia, which are on the leading edge of the infestation.

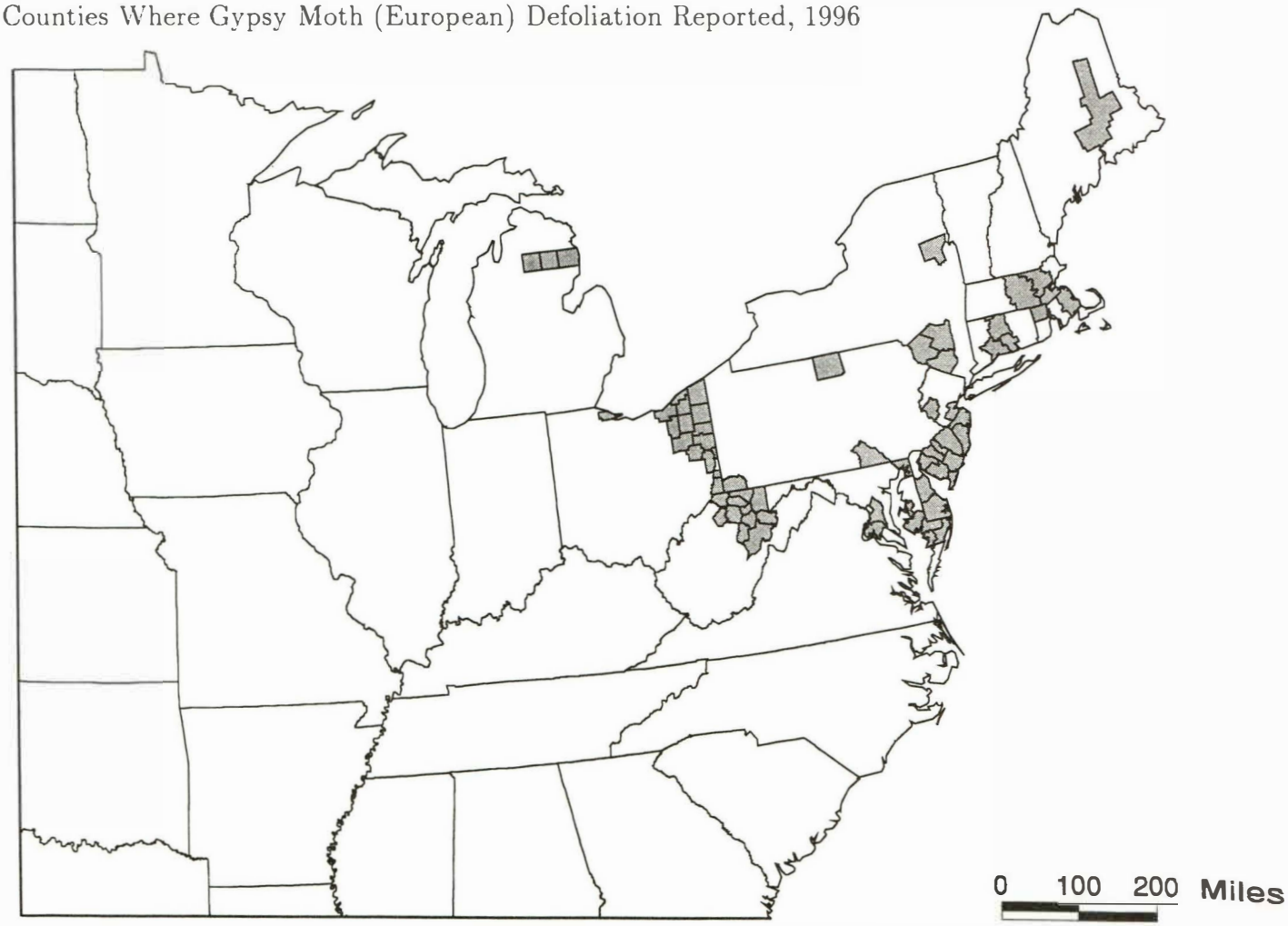
Eradication projects were conducted on outlying infestations of European gypsy moths in Georgia, North Carolina, Tennessee, and Wisconsin. Eradication projects were also conducted in Oregon and Washington.

Asian form

One moth was trapped in Washington and one larva was found at a port facility. An eradication project is planned for that site in 1997.

In 1993 the Asian form of the gypsy moth, along with European and hybrid forms, was accidentally introduced into the vicinity of Wilmington, North Carolina, on a ship returning U.S. military equipment from Germany. An eradication project was conducted in 1994, with over 140,000 acres treated. Follow-up treatments were conducted in 1995 and 1996. Trapping across a 1,000 square-mile-area in 1996 yielded no captured moths; trapping on a 100-square-mile area will be reported later.

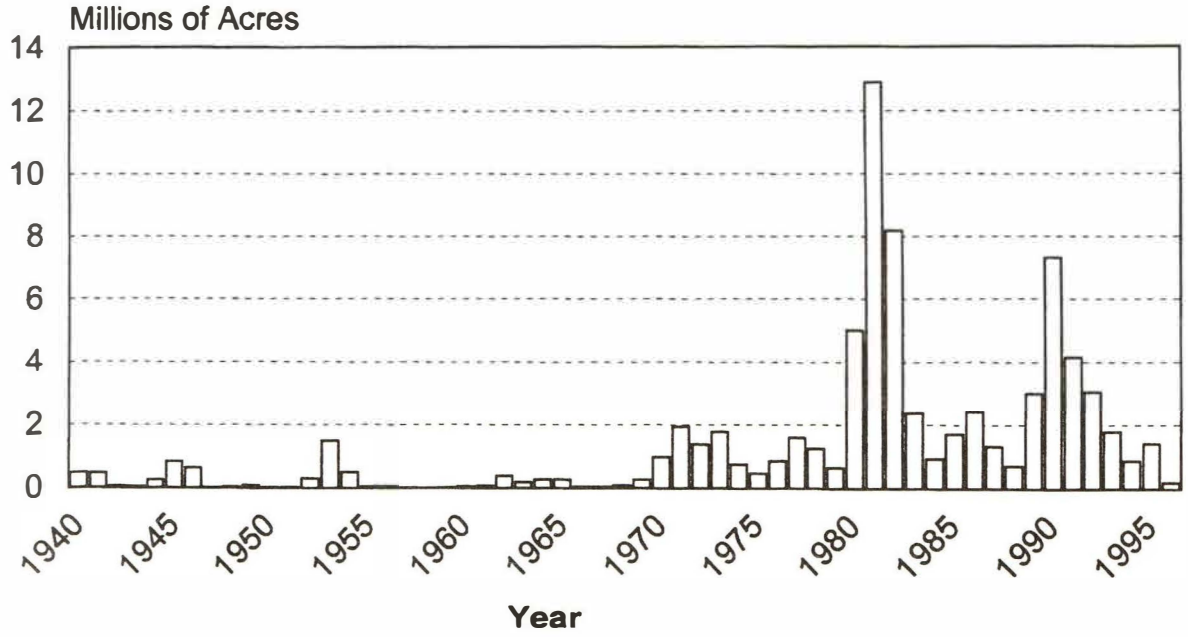
Counties Where Gypsy Moth (European) Defoliation Reported, 1996



Acres of Aerially Detected Gypsy Moth (European) Defoliation, 1992–1996

State	1992	1993	1994	1995	1996
Connecticut	31,637	0	0	2,700	1,400
Delaware	4,943	26,700	60,700	65,500	500
Maine	278,485	50,700	1,700	0	100
Maryland	38,704	68,900	93,200	93,900	11,200
Massachusetts	123,794	88,700	76,700	8,700	7,000
Michigan	712,227	399,300	97,300	85,900	5,000
New Hampshire	182,575	10,100	8,100	1,700	0
New Jersey	165,960	27,700	17,800	39,600	27,800
New York	60,022	2,000	500	200	16,300
Ohio	1,130	600	100	34,400	49,000
Pennsylvania	641,445	318,100	18,000	132,500	6,700
Rhode Island	0	0	400	0	4,000
Vermont	83	0	0	0	0
Virginia	748,000	589,100	452,500	849,000	0
Washington, DC	0	0	0	0	0
West Virginia	67,508	202,500	53,400	103,000	70,700
Total	3,056,513	1,784,400	880,400	1,417,100	199,700

Gypsy Moth (European) Defoliation, 1940–1996



Southern pine beetle

Dendroctonus frontalis, a native insect, is the most destructive of the eastern species of bark beetles. Southern pine beetle populations are epidemic in some parts of the South almost every year. Historically, eastern Texas and northwestern South Carolina have an inordinate amount of activity.

Annually, this beetle destroys timber trees worth millions of dollars and also affects recreation areas, shade trees, and general aesthetics. Infestations usually start in trees weakened by disease, lightning strikes, excessive age, storm damage, or other stress factors.

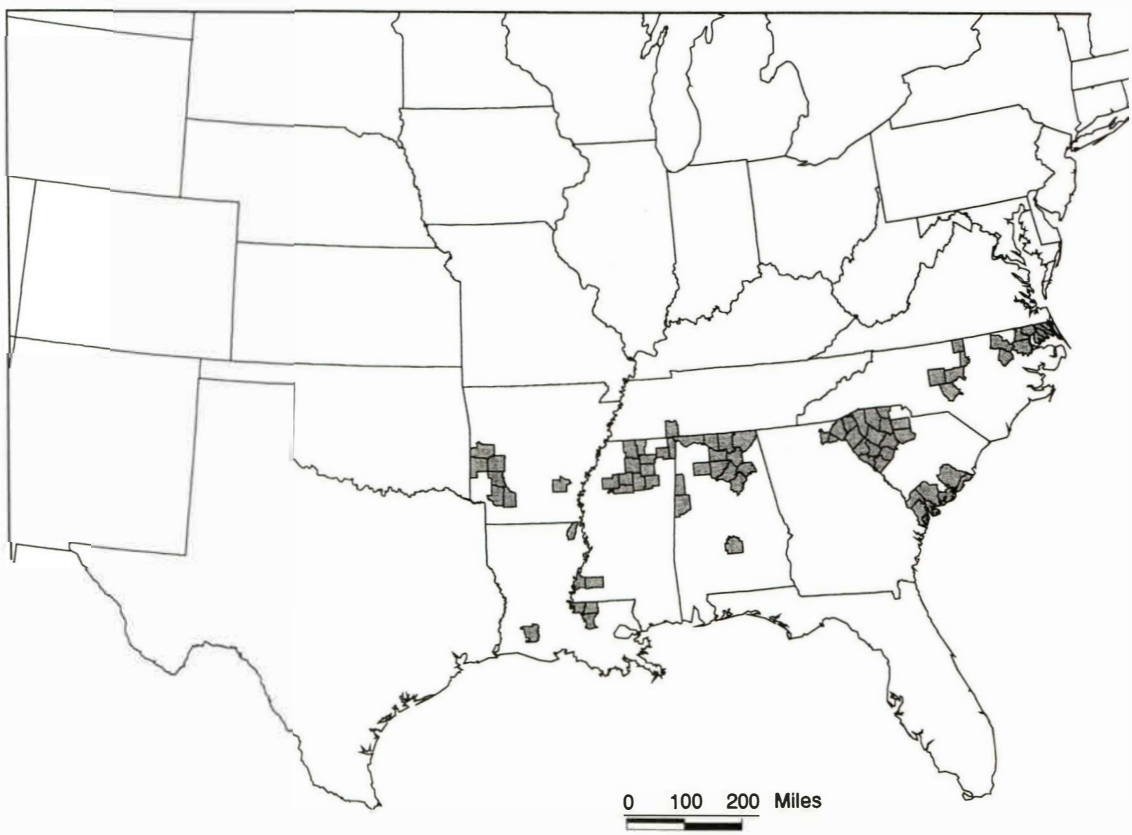
Acreage in the South affected by the southern pine beetle declined markedly from 21.7 million acres in 1995 to 7.3 million acres in 1996. A combination of factors are attributed to the decline; adverse environmental conditions, natural enemies, and land management suppression activities. Still populations reached outbreak levels* in parts of Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Tennessee. The majority of the activity occurred in early 1996 as a carryover of the high levels of southern pine beetle activity in 1995.

In 1995 the Governor of South Carolina established a forest disaster council to expedite the salvage of beetle-killed timber on private lands. With the decline in beetle activity, the Governor disbanded the council in July 1996.

Eighty-eight southern pine beetle infestations occurred within the Caney Creek Wilderness on the Ouachita National Forest in Arkansas. Seven of the infestations required control actions to protect adjacent private forested lands.

*Outbreak counties are defined as having one or more multi-tree infestations per 1,000 acres of host type.

Counties Where Southern Pine Beetle Outbreaks Reported, 1996

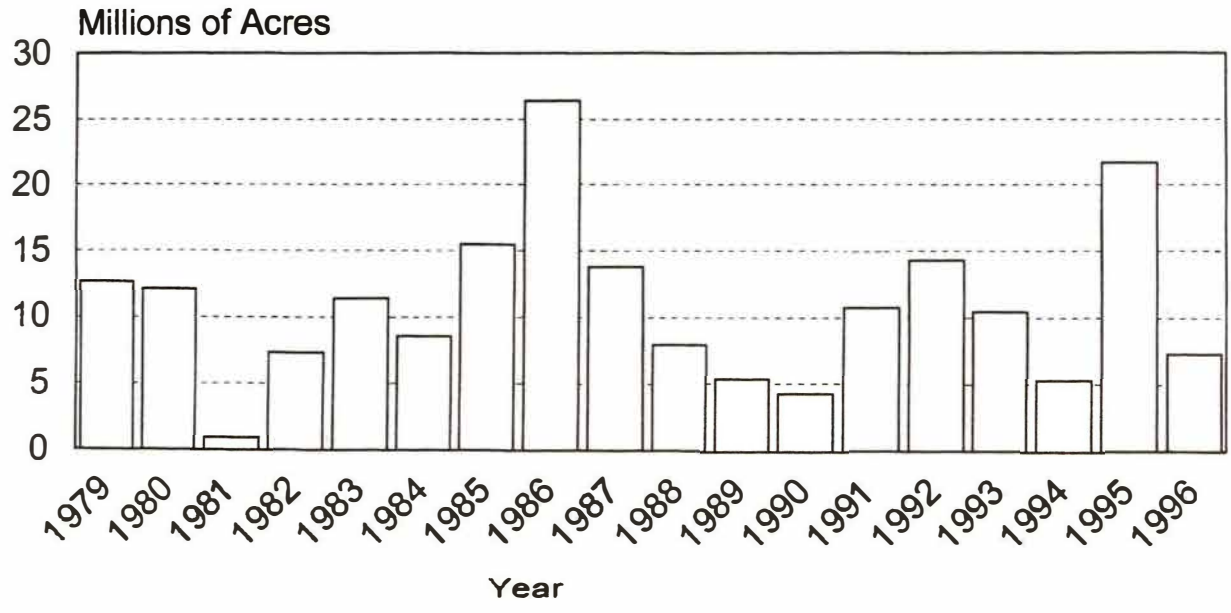


Acres (in thousands) of Southern Pine Beetle Outbreaks in Southern Region (R-8), 1992–1996*

State	1992	1993	1994	1995	1996
Alabama	5,815.7	2,753.4	2,951.4	6,552.4	1,177.9
Arkansas	55.8	649.1	429.6	2,112.9	1,420.6
Florida	0.0	0.0	97.1	736.0	0.0
Georgia	871.0	587.3	315.4	1,326.0	101.3
Kentucky	0.0	0.0	0.0	0.0	0.0
Louisiana	3,112.4	2,291.9	0.0	2,908.8	165.3
Mississippi	406.1	331.5	689.6	2,714.3	1,150.9
North Carolina	334.3	569.6	47.9	2,755.6	747.1
Oklahoma	0.0	0.0	0.0	0.0	0.0
South Carolina	469.2	366.4	332.8	2,542.9	2,496.6
Tennessee	45.9	173.0	148.6	0.0	41.2
Texas	2,663.3	1,106.8	238.3	0.0	0.0
Virginia	533.6	1,584.6	0.0	27.0	0.0
Total	14,307.3	10,413.6	5,250.7	21,675.9	7,300.9

*Acres of outbreak are acres of host type having one or more multi-tree spots per 1,000 acres.

Southern Pine Beetle Outbreaks in Southern Region (R-8), 1979–1996



Mountain pine beetle

Dendroctonus ponderosae is a native bark beetle that attacks lodgepole, ponderosa, sugar, western white, and other pines. The beetle ranges throughout western pine forests from Canada into Mexico. Beetles infest mature lodgepole pine and both mature and overstocked stand of other pines.

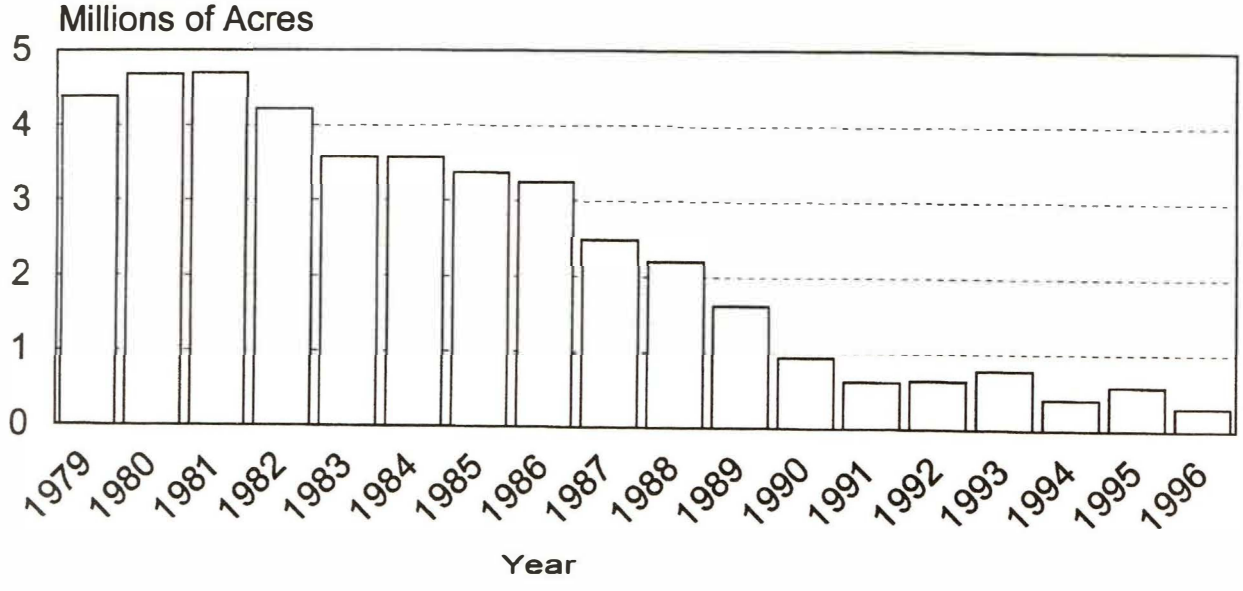
The trend to low populations that started in the 1980's continues. The total acreage infested decreased in 1996; the largest declines occurred in Oregon and Washington. The decline was not universal, as modest increases in affected acreages were reported for Arizona, Colorado, Idaho, and New Mexico. The affected acreage reported for Utah is the highest of the last 5 years. In Oregon and Washington, 2 years of normal precipitation have alleviated the drought-caused stress. However, there (as elsewhere) dense stand conditions predispose areas to damaging mountain pine beetle infestations.

Mountain Pine Beetle Outbreak Areas, 1996

Acres (in thousands) of Mountain Pine Beetle Outbreak, 1992–1996

State	1992	1993	1994	1995	1996
Arizona	0.0	0.0	0.2	0.2	2.2
California	---	121.0	115.0	58.9	25.1
Colorado	0.0	0.0	1.2	4.7	12.8
Idaho	22.4	43.7	7.8	13.9	33.4
Montana	65.9	43.4	19.2	31.3	27.6
New Mexico	1.2	1.4	2.8	0.4	1.1
Oregon	303.0	345.6	161.1	234.4	112.6
South Dakota	13.6	13.6	1.4	2.6	2.2
Utah	4.1	10.0	18.7	20,9	24.6
Washington	125,2	200.3	76.4	205.9	56.7
Wyoming	106.0	2.8	1.6	2.3	1.7
Total	641.4	781.8	405.4	575.5	300.0

Mountain Pine Beetle Infestations, 1979–1996



Spruce budworm

Choristoneura fumiferana is a native insect found in northern New England, New York, Pennsylvania, the Great Lakes area, and Alaska. Balsam fir is the preferred host, but the insect also feeds on white, red, and black spruce. Top kill and tree mortality may result from budworm feeding. Outbreaks generally begin in extensive and continuous areas of mature and overmature balsam fir.

In the East, the infestation in Minnesota declined from 485,000 acres to 208,000 acres in 1996. In addition, the acreage of defoliation on the eastern end of the Upper Peninsula of Michigan declined. A new infestation of 12,600 acres was detected on Isle Royale, an island in Lake Superior. Because Isle Royale is part of Keweenaw County, Michigan, the entire county is shaded on the map, but the infestation is only on the island. A 2,000-acre infestation was found in Pennsylvania-the first infestation in several years in that State.

In Alaska, some areas have experienced seven consecutive years of budworm defoliation by *C. fumiferana* var. *orae*, and var. *biennis*. The acres defoliated declined from 279,000 acres in 1995 to 236,000 acres in 1996. Of this acreage, 63 percent is on State and privately owned (including Native corporations) lands, and 37 percent on Federal lands.

Counties Where Spruce Budworm Defoliation Reported in Eastern United States, 1996

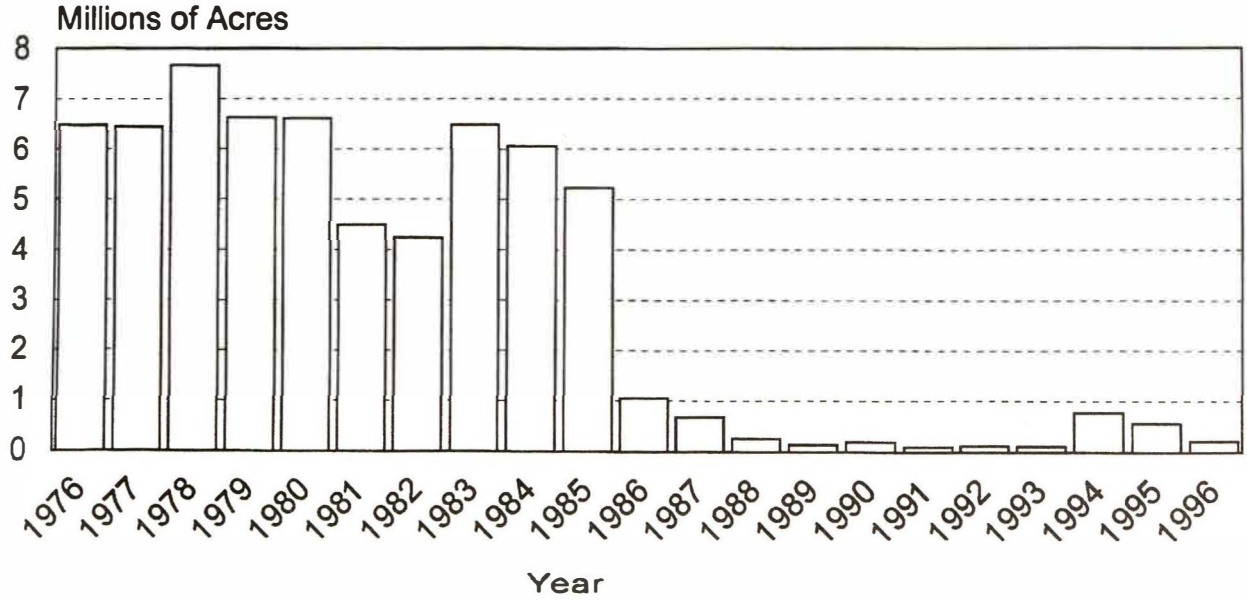
Acres (in thousands) of Aerially Detected Spruce Budworm Defoliation in Eastern United States, 1992–1996

State	1992	1993	1994	1995	1996
Maine	0.0	0.0	0.0	0.0	0.0
Michigan	0.0	0.0	6.8	51.2	12.9
Minnesota	126.0	116.0	770.5	505.0	207.6
New Hampshire	0.0	0.0	0.0	0.0	0.0
New York	0.0	0.0	0.1	0.4	0.0
Pennsylvania	0.0	0.0	0.0	0.0	2.0
Vermont	0.0	0.0	0.0	0 0	0.0
Wisconsin	0.0	0.0	1.0	12.5	0.0
Total	126.0	116.0	778.4	569.1	220.5

Acres (in thousands) of Aerially Detected Spruce Budworm in Alaska, 1992–1996

State	1992	1993	1994	1995	1996
Alaska	160.0	33.0	232.5	279.1	235.9

Spruce Budworm Defoliation in Eastern United States, 1976–1996



Western spruce budworm

Choristoneura occidentalis defoliation remains generally low throughout the West. In 1995 no budworm defoliation was observed in Montana or northern Idaho for the first time since aerial surveys began in 1948. No budworm was observed again in 1996, the second consecutive year. Also, no defoliation was observed in the Intermountain Region (southern Idaho, Utah, and Nevada) for the third consecutive year. However, in Colorado tree mortality is occurring in some areas repeatedly defoliated over the past decade. Budworm defoliation decreased in Arizona and New Mexico. In Washington and Oregon the area of visible defoliation decreased slightly, but there was an observable intensification of the defoliation in surveyed areas.

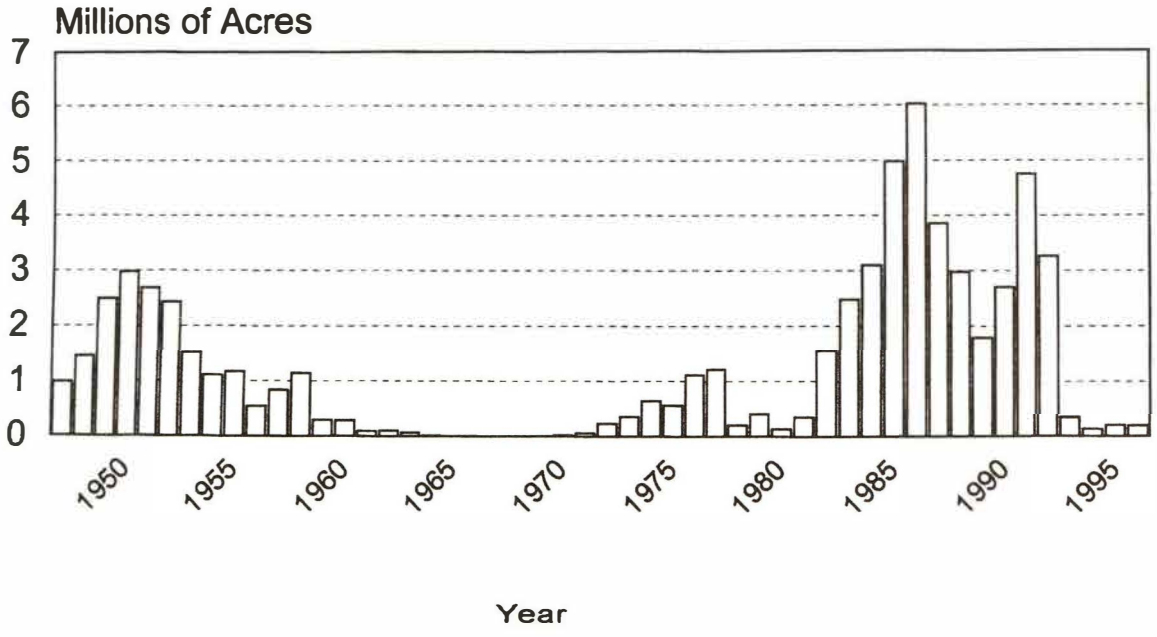
Epidemics cause reduced growth, tree deformity, top kill, and tree mortality on extensive areas. Trees weakened by defoliation are often predisposed to attack by bark beetles. The exclusion of fire has resulted in an abundance of the budworm's favorite food: shade-tolerant, late-successional species such as true fir.

Western Spruce Budworm Defoliation Areas, 1996

Acres (in thousands) of Aerially Detected Western Spruce Budworm Defoliation, 1992–1996

State	1992	1993	1994	1995	1996
Arizona	11.5	0.0	0.0	7.0	3.0
California	0.0	0.0	0.0	0.0	0.0
Colorado	272.2	1.2	0.0	97.0	21.8
Idaho	89.8	0.9	0.0	0.0	0.0
Montana	941.3	44.2	2.4	0.0	0.0
New Mexico	9.4	66.4	369.2	183.8	123.9
Oregon	1,937.7	87.7	37.4	14.9	1.0
Utah	0.0	0.0	0.0	0.0	0.0
Washington	1,329.5	243.8	85.4	175.1	183.2
Wyoming	2.5	2.5	1.1	0.0	0.0
Total	4,593.9	446.7	495.5	477.8	332.9

Western Spruce Budworm Defoliation in Pacific Northwest Region (R-6), 1947–1996



Hemlock woolly adelgid

Adelges tsugae was reported on the West Coast in the 1920's, probably imported from Asia. The adelgid does very little damage in western forests, but sometimes kills ornamental trees.

However, the hemlock woolly adelgid poses a serious threat to the eastern hemlock. The adelgid can kill eastern hemlock trees in 3 to 5 years. In 1950 the insect was introduced into the East Coast near Richmond, Virginia, and has spread north into southern New England. No new counties were found infested in 1996 in the northeast.

In Virginia, hemlocks are infested, except for those in the southwestern counties, and decline and mortality are extensive. In 1995, infestations were found in two counties in North Carolina; the first report of the insect in that State. Infestations were found in two additional counties in North Carolina in 1996.

The eastern hemlock has important aesthetic qualities in scenic areas, campgrounds, and recreation areas. The loss of eastern hemlock from stream banks is a threat to trout because shade from the tree limbs help maintain cool water temperatures.

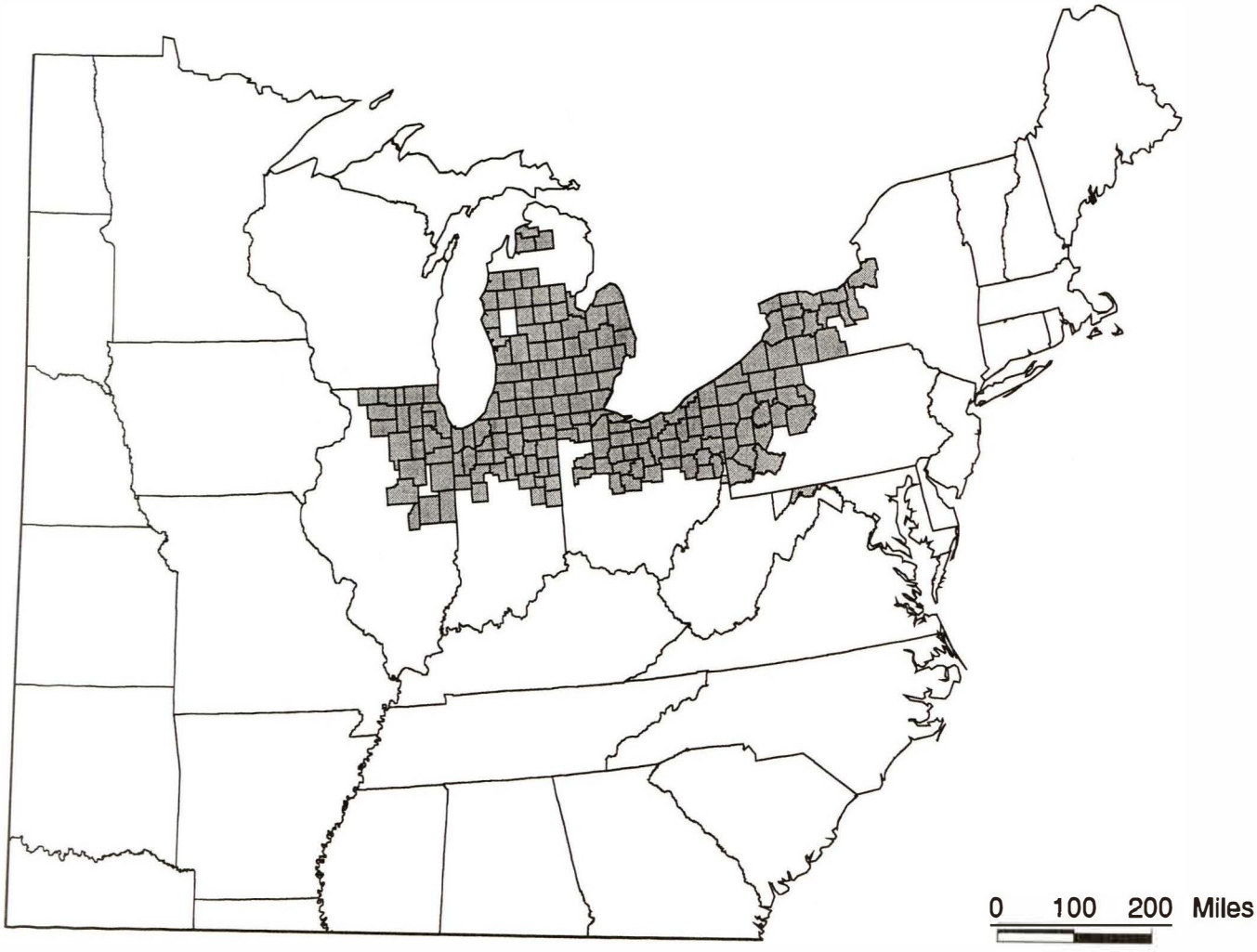
Counties Where Hemlock Woolly Adelgid Reported, 1996

Common European pine shoot beetle

Tomicus piniperda is an introduced insect discovered near Cleveland, Ohio, in 1992. In April 1995, beetles were found in Maryland and West Virginia as well as in the previously reported States—Illinois, Indiana, Michigan, New York, Ohio, and Pennsylvania. The beetle continued to spread within these States in 1995. Infestations were found in an additional 65 counties in 1996. The beetle has also been found in 10 counties in Ontario, Canada.

The beetle prefers Scotch pine but feeds on other pines as well. Thus far, the beetle is a problem mainly for Christmas tree growers. A native of Europe and Siberia, the beetle causes serious damage to trees in burned over areas and areas experiencing severe drought. Because of the damage potential to trees in the United States, infested counties have been placed under State and Federal quarantine to prevent movement of this beetle to new areas. In 1994, Mexico set a quarantine on shipment of Christmas trees from infested counties into Mexico.

Counties Where Common European Pine Shoot Beetle Reported, 1996



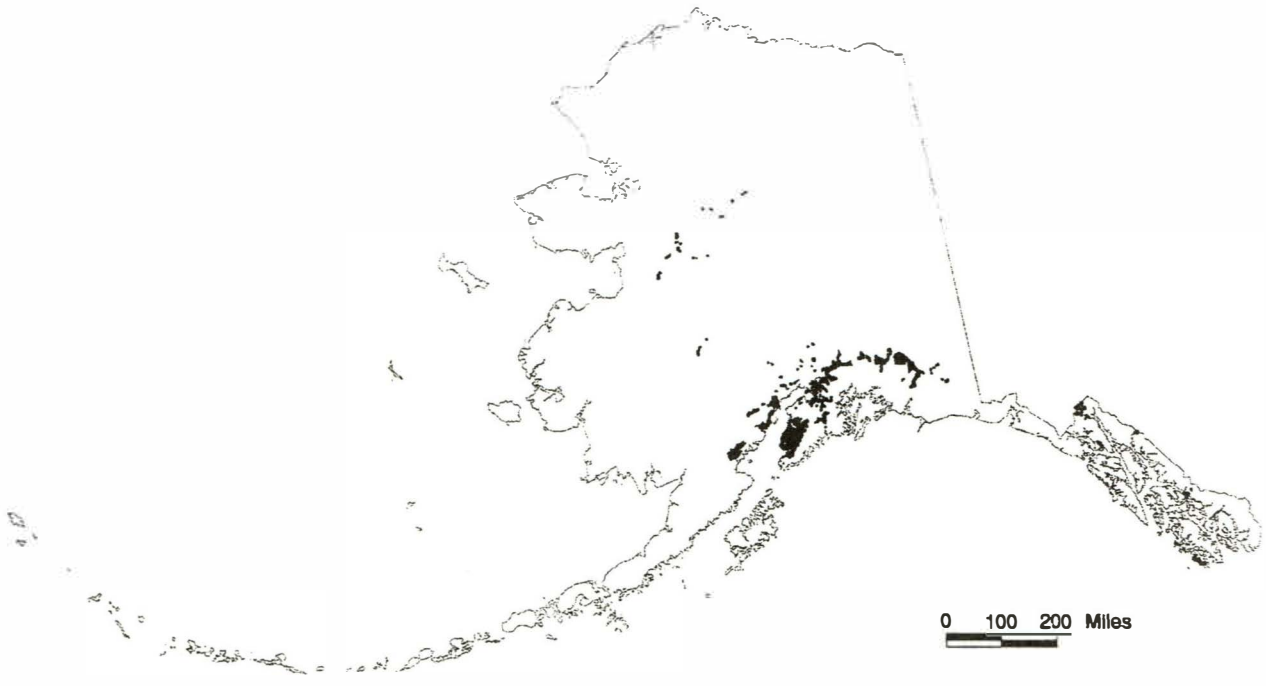
Spruce beetle

Dendroctonus rufipennis is a native insect that occurs across northern North America and south in the Rocky Mountains to Arizona. Spruce beetle is the most significant mortality agent of mature spruce. Beetle populations also build up in windthrown trees. Besides killing merchantable trees, infestations affect habitat quality for wildlife and fish, reduce scenic quality, and increase fire hazard and long-term ecosystem conversion.

The infestations in Alaska continued to increase in size reaching 1.1 million acres of active and newly infested areas in 1996. Over 458,000 acres of the infestation is on the Kenai Peninsula. Statewide several ownerships are affected; 67 percent of the infestations occurring on State and private lands including native corporations, 31 percent on Federal lands (National Park Service, Bureau of Land Management, National Wildlife Refuge, and Military), and 2 percent on National Forest System lands.

Infestations remain generally low in the western States, however increased activity was observed on most national forests in Utah, and on the Okanogan National Forest in Washington. In many cases the acreage of susceptable host type has declined due to gradual removal of preferred host trees by previous infestations and by wildfire. In the East, a considerable expansion of beetle activity was observed on the costal islands of Maine.

Spruce Beetle Active and Newly Infested Areas in Alaska, 1996



Disease Conditions Highlights

Dogwood anthracnose

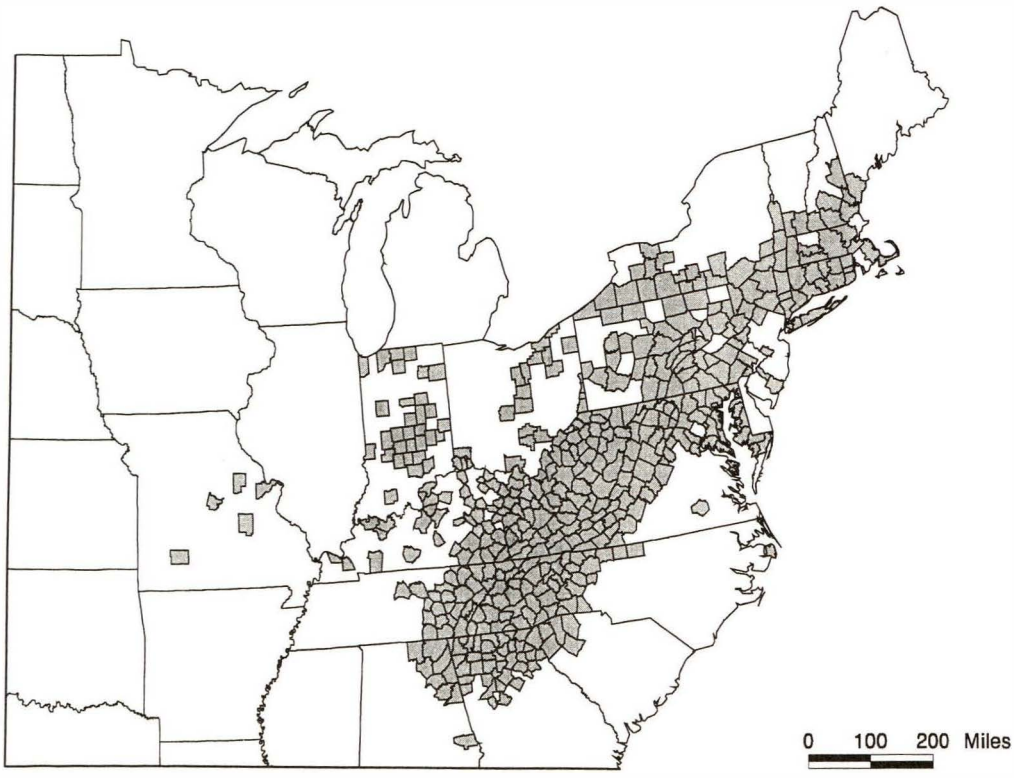
Discula destructiva, the fungus that causes dogwood anthracnose, is of unknown origin. A new fungus may have been introduced or a previously innocuous fungus may have become a significant pathogen. The disease was first discovered in the Pacific Northwest in 1976 and is now confirmed in Idaho, Oregon, and Washington.

In the East, the fungus was first found in southeastern New York in 1978. By 1987, it was found in nine eastern States from Massachusetts to Georgia, and by 1994 it was confirmed in 21 States from Maine to Alabama and west as far as Indiana and Missouri. Infected nursery shipments are implicated in this most recent western spread, but in Indiana at least, native stands are now infected. No new infested States or counties were reported in 1996; however, the disease increased in some of the affected counties.

The range of dogwood extends from southern Maine to Florida and west to Michigan and eastern Texas. The disease affects both woodland and ornamental dogwoods. In the South, damage is most severe at higher elevations and in cool, moist areas in lower elevations. Control measures are available for ornamental trees but are not practical in the general forest.

Although the Pacific dogwood is more susceptible than the eastern dogwood, drier summers in the West reduce the number of infection cycles. Thus, although significant mortality has occurred in the Pacific Northwest, the problem is not as severe as it is in the East.

Eastern Counties Where Dogwood Anthracnose Reported, 1996

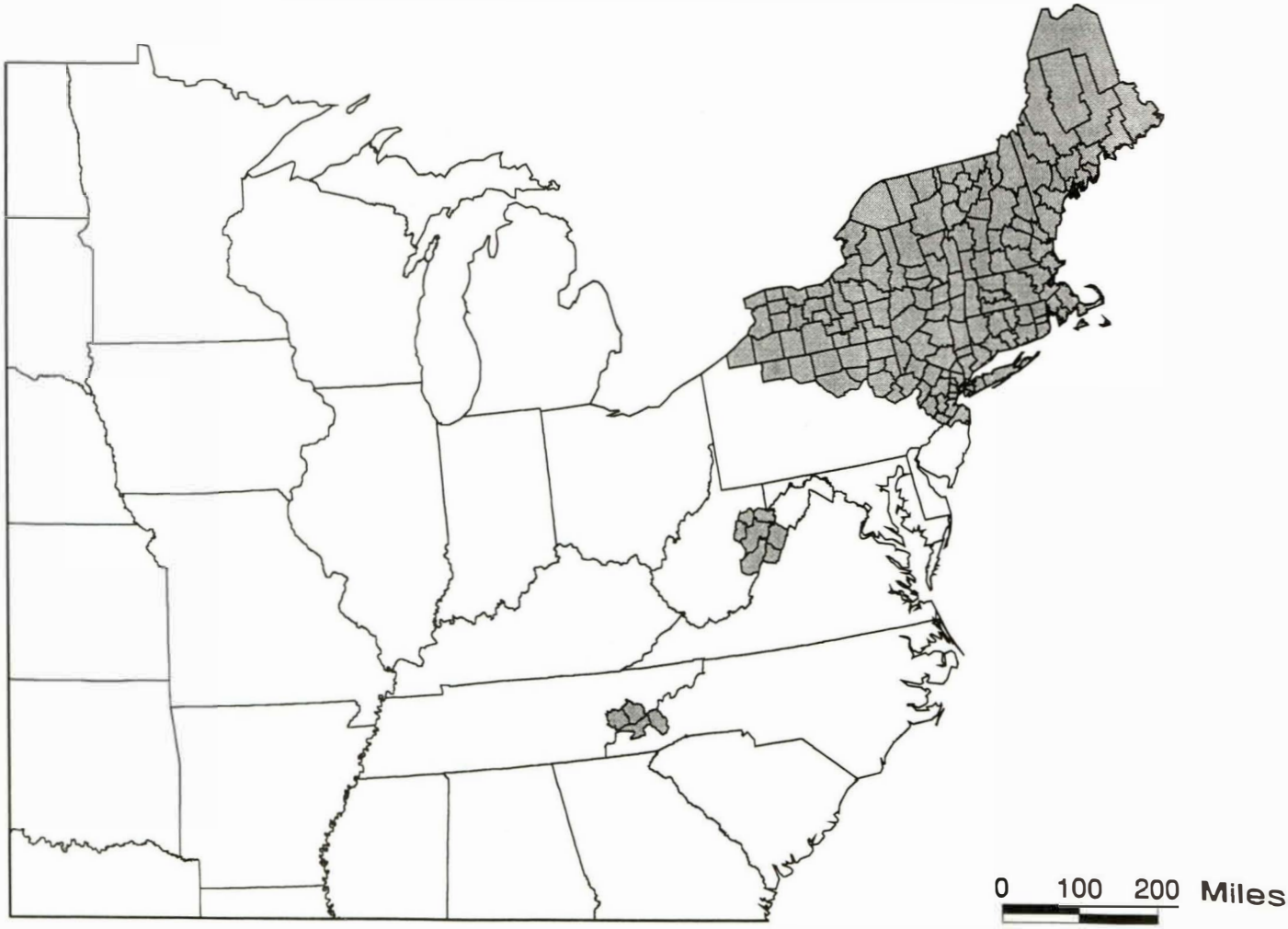


Beech bark disease

This disease results from attack by the beech scale, *Cryptococcus fagisuga*, followed by invasion of the fungus *Nectria coccinea* var. *faginata*. About 1890, the scale was accidentally introduced into eastern Canada. By 1932, the disease was killing trees in Maine and, by 1981, had spread to West Virginia. In 1994 the disease was found affecting approximately 100 acres in three counties on the North Carolina–Tennessee border (within the Great Smoky Mountains National Park), about 300 miles southwest of its previously known distribution. This area of infestation increased in size in 1995. An increase in scale distribution and proliferation of *Nectria* mortality centers continued in 1996 in the tri-county area.

The range of American beech is from Maine to northwestern Florida west to the eastern parts of Wisconsin and Texas. Considerable beech mortality has occurred in the Northeast south to Pennsylvania.

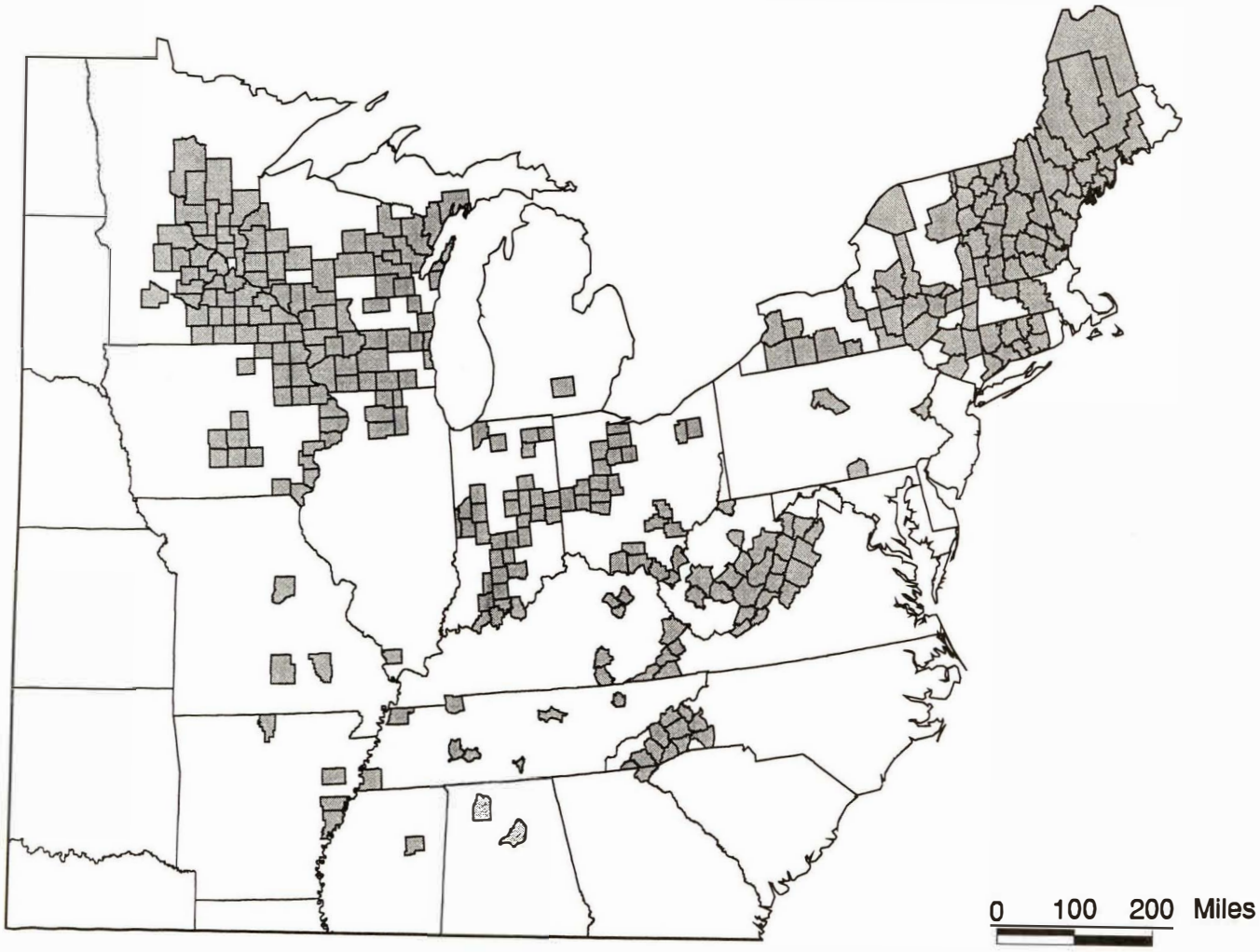
Counties Where Beech Bark Disease Reported, 1996



Butternut canker

Sirococcus clavigignenti-juglandacearum is the fungus that causes butternut canker. The origin of this fungus is unknown. Symptoms of the disease have been recognized since the early 1900's, but the causal fungus was not identified until the late 1970's. The range of butternut is from Maine to Georgia on the east, then west to Minnesota and Arkansas. The disease is found throughout most of the range and is a serious threat to the survival of the species. The Forest Service and some States have imposed a moratorium on harvesting healthy trees in the hopes of finding resistant stock. Trees exhibiting resistance have been found, and these trees are being propagated for host resistance studies. There are no known control measures.

Counties Where Butternut Canker Reported, 1996



Fusiform rust

Cronartium quercuum f. sp. *fusiforme*, a native fungus, continues to be the most damaging disease agent of loblolly and slash pines in the South. An estimated 13.4 million acres of pines are affected. Acres are classified as affected if more than 10 percent of the trees have potentially lethal cankers. Georgia is the most seriously affected State, with 4.6 million acres (49 percent), of host type affected. New areas of severe fusiform rust infestation were discovered in South Carolina in 1996.

Acres (in thousands) Affected by Fusiform Rust, 1996*

State (survey year)	National Forest System	Other Federal	State and Private	Total
Alabama (90)	7.1	0.0	1,704.2	1,711.3
Arkansas (88)	0.0	0.0	166.9	166.9
Florida (87)	20.8	9.8	1,135.9	1,166.5
Georgia (89)	38.0	102.8	4,452.9	4,593.7
Louisiana (91)	85.0	18.4	1,554.9	1,658.3
Mississippi (87)	118.0	60.0	1,043.0	1,221.0
North Carolina (90)	4.9	7.8	956.2	968.9
Oklahoma (92)	0.0	0.0	33.9	33.9
South Carolina (95)	46.0	59.0	1,303.0	1,408.0
Texas (92)	21.8	0.0	397.3	419.1
Virginia (92)	0.0	0.0	59.3	59.3
Total	341.6	257.8	12,807.5	13,406.9

*Acres with greater than 10 percent infection.

Dwarf mistletoes

(*Arceuthobium* spp.) are parasitic plants that invade the branchwood of host trees. These pest species are associated with much of the tree mortality in the West. Conifers on about 29 million acres of western forests are infected. Mistletoe infection reduces tree growth and seed crops, kills tops, branches, and entire trees. Growth loss totals about 180 million cubic feet of wood annually. Most of the volume loss is caused by 7 of the 19 dwarf mistletoe species: those on Douglas-fir, lodgepole pine, true fir, western hemlock, western larch, and 2 species on ponderosa pine.

In the past, forest fires helped reduce the incidence of dwarf mistletoes. The advent of fire control has had the inadvertent effect of allowing dwarf mistletoes to increase in severity.

Acres (in thousands) in the West Affected by Dwarf Mistletoes, 1996

State (survey year)	National Forest System	Other Federal	State and Private	Total
Alaska*	3,060.0	0.0	340.0	3,400.0
Arizona (85-89)	1,040.0	674.0	25.0	1,739.0
California (80-90)	2,276.0	69.0	1,911.0	4,256.0
Colorado (79,82)	638.0	---	---	638.0
Idaho---North (70-80)**	478.0	10.0	224.0	712.0
Idaho---South (94)**	2,672.5	---	---	2,672.5
Montana (70-80)	1,694.0	123.0	600.0	2,417.0
New Mexico (85-89)	1,140.0	348.0	581.0	2,069.0
Nevada (94)	49.5	---	---	49.5
Oregon (67)	1,137.0	43.0	2,760.0	3,940.0
Utah (94)	395.9	---	---	395.9
Washington (76)	2,703.3	505.0	2,470.0	5,678.0
Wyoming (94)	915.0	---	---	915.0
Total	18,198.9	1,772.0	8,911.0	28,881.9

*Commercial acreage only in Alaska.

**Idaho—North is in region 1, and Idaho—South is in region 4.

Part 2 Conditions by Damage Agent by Region

Insects: Native

Cherry scallop shell moth,
Hydria prunivorata

Region 9/Northeastern Area: Michigan, New Hampshire, New York, Ohio, Pennsylvania, Vermont, West Virginia

Host(s): Beech, black cherry

Cherry scallop shell moth populations declined significantly from 924,956 acres in 1995 to almost 19,500 acres in the region in 1996. Most of the defoliation occurred in Pennsylvania on about 16,000 acres of Allegheny National Forest and State and privately owned lands. This included 1,180 acres of mortality of black cherry in Pennsylvania. West Virginia detected 3,424 acres of defoliation during aerial survey, Ohio reported 19 acres, and New Hampshire only 10 acres of defoliation. No activity was reported from Michigan, New York, and Vermont in 1996.

Cypress looper,
***Anacamptodes* pergracilis**

Region 8: Florida

Host(s): Baldcypress and pondcypress, *Taxodium* spp.

Last year's unusual outbreak of this cypress defoliator, which caused noticeable (greater than 30 percent) defoliation on over 500,000 acres in 7 Florida counties, has declined significantly during 1996.

Douglas-fir beetle,
Dendroctonus pseudotsugae

Region 1: Idaho, Montana, Wyoming

Host(s): Douglas-fir

Area infested by the Douglas-fir beetle decreased in the region from nearly 21,000 acres in 1995 to slightly more than 7,300 acres in 1996. The most significant decreases occurred in stands throughout northern Idaho—down from 15,000 acres to fewer than 3,000 acres—as a result of a return to more seasonable weather throughout the winter of 1995-96, and the growing season of 1996. There was also a slight decrease in infested area in western Montana; from 5,800 acres infested in 1995, to only 4,300 in 1996. Improved weather and timely removal of infested trees were important factors in reducing the amount of area being affected by beetles.

Region 2: Colorado, Wyoming

Host(s): Douglas-fir

An extensive outbreak in western Colorado and eastern Utah has been in progress for several years. In Colorado, from Rifle west to the Douglas Pass area to the Utah border, about 7,250 trees were killed in 1996. Because previously killed snags outnumber current faders, it is likely that this

outbreak is declining. Scattered mortality was found in parts of the Wet Mountains in the San Isabel National Forest and an area between Pagosa Springs and Bayfield in the San Juan National Forest. These areas are expected to have continued beetle activity. Many trees that were burned by the Buffalo Creek fire were found to be heavily infested; it is possible that this may set off an outbreak in the South Platte River drainage. Nearby, additional mortality is occurring in areas heavily defoliated from 1993-1995 by the Douglas-fir tussock moth. Mortality along the Colorado Front Range continues to occur in small, widely scattered groups. Most mortality is on steep inaccessible slopes where western spruce budworm had defoliated trees over the past decade. On the Shoshone National Forest in Wyoming, the epidemic appears to be subsiding on the Clarks Fork and Wapiti Ranger Districts. About 1,000 trees were killed in 1996.

Region 3: Arizona, New Mexico

Host(s): Douglas-fir

Douglas-fir beetle-caused tree mortality increased regionwide—from 570 acres affected in 1995 to 835 acres in 1996. Mortality occurred on the Apache-Sitgreaves National Forests (570 acres), Coconino National Forest (150 acres), Kaibab National Forest (55 acres), and the Fort Apache Indian Reservation (5 acres), Arizona, and on the Gila National Forest (25 acres) and Santa Fe National Forest (30 acres) in New Mexico.

Region 4: Idaho, Utah

Host(s): Douglas-fir

Regionwide mortality increased, with 62,675 trees killed in 1996. Outbreaks were located on the Sawtooth, Boise, Salmon, and Payette National Forests in Southern Idaho. In Utah, tree mortality decreased with 8,600 trees killed in 1996 and 11,500 trees killed in 1995. The largest outbreaks are located on the Manti-LaSal and Ashley National Forests. Smaller outbreaks are located on other national forests in Utah. Mortality on the Bridger-Teton National Forest in western Wyoming decreased from 2,000 trees in 1995 to 1,500 trees in 1996.

Region 5: Northern California

Host(s): Douglas-fir

Only a few scattered trees were killed in 1996. However, Douglas-firs that were blowdown or storm damaged by high winds in December 1995 became infested by Douglas-fir beetle. This could result in increased attacks during 1997.

Region 6: Oregon, Washington

Host(s): Douglas-fir

Douglas-fir beetle activity decreased throughout much of the region for the third straight year, from 44,200 acres averaging 0.59 affected tree/acre in 1995 to 9,700 acres with an average of 0.80 tree/acre in 1996. Increased levels of activity were detected on the Colville National Forest and the Colville Indian Reservation and in the Puget Sound area. An unexpected decrease in acres affected was observed in the Umatilla and Wallowa-

Whitman reporting areas, apparently due to depletion of most large, older brood trees that were responsible for maintaining high numbers of beetles in some areas. Predisposing tree stresses caused by repeated years of defoliation by western spruce budworm, drought, and overstocking were expected to result in relatively high levels of Douglas-fir beetle activity for a few more years, despite 2 years of normal precipitation.

Beetle habitat created by numerous recent fires will likely result in increases in Douglas-fir beetle population increases in 1997. Increased Douglas-fir beetle activity are expected in the summer of 1998 due to a windstorm on December 12, 1995, and extensive flooding during February 1996.

Douglas-fir tussock moth, *Orgyia pseudotsugata*

Region 1: Idaho, Montana

Host(s): Douglas-fir, spruce, true firs

Douglas-fir tussock moth populations remained at low levels in 1996. No aerially visible defoliation was detected, nor were any larvae found at those sites that were sampled. Moth catches in pheromone traps were at increased levels in Idaho and Montana. At 68 sites in Idaho, 128 moths were caught in 1996 compaired to 27 in 1995. The Montana trap catch was 12 in 1996, up from zero in 1995. Populations are expected to remain low in 1997.

Region 2: Colorado

Host(s): Douglas-fir

No defoliation was detected in 1996, showing that the epidemic of 1993-1995 has completely collapsed. An early warning system using pheromone traps detected no areas of Douglas-fir tussock moth increase. It appears that Douglas-fir beetle populations increased in heavily defoliated stands and are now attacking trees in adjacent areas.

Region 4: Idaho, Nevada, Utah

Host(s): Douglas-fir, true firs

No visible defoliation from Douglas-fir tussock moth was observed in the region during 1996.

Region 5: Northern California

Host(s): White fir

Data were collected for 149 plots (5 traps/plot) in 1996. Numbers of male moths caught in monitoring traps were high for the second consecutive year in several locations from northeastern California southward to the Eldorado and Stanislaus National Forests—50 percent of the plots averaged greater than 25 male moths/trap. Only minor defoliation of scattered individual white firs has been found thus far. Egg mass and larval surveys are planned for 1997.

Insects: Native

Region 6: Oregon, Washington

Host(s): Douglas-fir, true firs

Following a 3-year low of 2,900 defoliated acres reported in 1995, we observed no Douglas-fir tussock moth activity during the aerial survey of the Region in 1996.

Elm spanworm, *Ennomos subsignaris*

Region 9/Northeastern Area

Hosts: Sugar maple

Populations of the elm spanworm peaked in Pennsylvania and New York in 1993 and 1994, defoliating over a million acres. Populations dropped considerably in 1995 to 30,000 acres. No significant activity was reported in 1996.

Fir engraver beetle, *Scolytus ventralis*

Region 1: Idaho, Montana

Host(s): Grand Fir, subalpine fir

The number of fir engraver beetle–infested stands decreased dramatically in northern Idaho in response to a return to more nearly normal precipitation during the winter of 1995-96 and the summer of 1996. Populations in western Montana remained typically low. In 1995, more than 242,000 acres showing some level of beetle activity were mapped in northern Idaho. That decreased to less than 19,000 acres in 1996. The largest concentrations of engraver beetles were observed on the Idaho Panhandle and Nez Perce National Forests, although other reporting areas in northern Idaho showed significant infestations, as well. Fir engraver populations remained at near endemic levels in western Montana, where only about 400 acres of infested stands were recorded in 1996. Most of those infested acres were on the Lolo National Forest. A continuing reduction in infested area may be anticipated in 1997 as a result of precipitation received during winter 1996-97.

Region 3: Arizona, New Mexico

Host(s): True firs

Tree mortality from fir engraver beetle attacks was detected on 2,820 acres of susceptible host type in 1996 compared to 2,685 acres in 1995. Mortality on Federal lands in Arizona occurred on the Apache-Sitgreaves National Forests (670 acres), Coconino National Forest (20 acres), Coronado National Forest (10 acres), Kaibab National Forest (1,480 acres), Grand Canyon National Park (160 acres), and Navajo Indian Reservation (50 acres); and in New Mexico on the Carson National Forest (10 acres), Santa Fe National Forest (45 acres), Gila National Forest (80 acres), Lincoln National Forest (165 acres) and Mescalero Apache Indian Reservation (375 acres).

Region 4: California, Idaho, Nevada, Utah

Host(s): Grand fir, red fir, subalpine fir, white fir

Regionwide tree mortality decreased 65 percent, with 46,400 trees killed in 1996 compared to 133,400 trees in 1995. Only 200 trees were killed in southern Idaho in 1996 compared to 400 trees in 1995. Fir engraver beetle-caused tree mortality in Utah also decreased, with 12,300 trees killed in 1996 compared to 78,800 trees killed in 1995. Most fir mortality was located on the Uinta and Manti-LaSal National Forests, where 2,300 and 3,500 dead trees, respectively, were observed. Mortality was also observed on the Dixie, Fishlake, and Wasatch-Cache National Forests. In the areas surveyed in Nevada, activity decreased from 61,200 trees killed in 1995 to 37,100 in 1996. Mortality is located primarily on Federal, State, and private lands in the Tahoe Basin area and adjacent areas of the Toiyabe National Forest.

Region 5: California

Host(s): Red fir, white fir

White fir mortality is much reduced from recent years. Scattered mortality was still common in the Southern Cascades and some areas of concentrated mortality were detected in the northern Sierra Nevada. Top-kill and mortality of true fir was low in the central and southern Sierra Nevada. Small pockets of white fir mortality were reported from the Modoc Plateau. White fir mortality was scattered in the San Bernardino Mountains of southern California.

Region 6: Oregon, Washington

Host(s): True firs

Fir engraver activity was reported on fewer acres within the region but with higher levels of tree mortality. Acres affected decreased from 573,600 in 1995 (0.80 tree/acre) to 377,600 in 1996 (2.15 trees/acre). Despite 2 years of about normal precipitation, outbreaks have continued in areas that have experienced drought, defoliation by Douglas-fir tussock moth or western spruce budworm, or infection with root disease. Many of the most heavily infested areas are pine sites that, due to selective logging and fire exclusion, now have a large component of true fir.

Forest tent caterpillar, *Malacosoma disstria*

Region 8: Florida, Louisiana

Host(s): Oaks, tupelo, gum, other hardwoods

In Louisiana, the forest tent caterpillar infested tupelo and other bottomland hardwoods throughout 1996. Trees on 110,000 acres were defoliated. In addition, 80,000 affected acres showed greater than 50 percent defoliation and 55,000 acres less than 50 percent, for a total of 245,000 acres. Significant growth loss (about 50 percent of radial growth) occurred on 190,000 acres.

An unprecedented outbreak of forest tent caterpillar in west-central Florida continued to cause noticeable-to-complete defoliation of oaks in portions of six counties (Hardee, Hillsborough, Pinellas, Mantee, Polk, and Sarasota) for the third or fourth consecutive year. Oaks in neighboring Citrus, Hernando, Pasco, and Sumter Counties also experienced unusually high populations in 1996. High incidences of diseased/dead larvae were evident in Hardee, Hillsborough, Manatee, and Polk Counties. Larvae from these counties were diagnosed with various maladies, including polyhedrosis virus, *Entomophaga* fungus, and septocemia. Where infected larvae were prevalent, a corresponding lack of pupal cacoons and adult moths were noted, indicating a potential end to this nuisance pest in the near future.

Region 9/Northeastern Area: Maryland, Maine, Minnesota, Missouri, New Hampshire, New York, Ohio, Pennsylvania, Rhode Island, Vermont

Host(s): Aspen, basswood, birch, black cherry, black gum, oaks, red oak, sugar maple, sweetgum, white ash, white oak

In Maryland, areas showing defoliation dropped to 4,263 acres in 1996 from nearly 17,000 acres in 1995. Larvae were found in Maine but there was no observable defoliation. Minnesota reported about 15,000 acres of defoliation on State and privately owned lands up from the 9,410 acres reported in 1995. The insect was detected on a small number of trees in Missouri. In New York, 75 acres of sugar maple were killed. In Pennsylvania, 54,257 acres of oak forest were defoliated. In Vermont, individual larvae were observed but no damage was detected. No activity was reported in New Hampshire, Ohio, and Rhode Island in 1996.

Jack pine budworm, *Choristoneura pinus*

Region 9/Northeastern Area: Michigan, Minnesota, Wisconsin

Host(s): Jack pine

Defoliation occurred in the national forests of the northern Lower Peninsula of Michigan. The total number of acres affected was about 12,000 in 1996, a slight decrease from the previous year. Minnesota reported 74,776 acres of defoliation throughout the central counties of the State, up from the 66,491 acres reported in 1995. The infestation continued to decline in Wisconsin, where a total of 8,000 acres were affected by defoliation in Bayfield and Douglas Counties. No mortality was reported in any of the three States.

Jeffrey pine beetle, *Dendroctonus jefferyi*

Region 4: California, Nevada

Host(s): Jeffrey pine

Jeffrey pine beetle activity declined on the Toiyabe National Forest, with 4,100 trees killed in 1995. Scattered tree mortality continues to occur in the Tahoe Basin area and other areas on the Toiyabe National Forest.

Region 5: California

Host(s): Jeffrey pine

Mortality of Jeffrey pine has declined in the Southern Cascades section. Areas where mortality remain include pockets of old growth in the Thousand Lakes Wilderness, Lassen National Forest; Lassen Volcanic National Park and adjacent Lassen National Forest; and other locations on the Eagle Lake District, Lassen National Forest. The beetle also attacked blowdown on this district.

In the northern and central Sierra Nevada, some areas of concentrated Jeffrey pine mortality were observed on the Plumas National Forest. Activity of the beetle remained high in several areas on the eastside districts of the Tahoe National Forest. Mortality associated with the Jeffrey pine beetle continued at reduced, but above background, rates in the vicinity of Lake Tahoe, adjacent areas on the Toiyabe National Forest in Nevada, and on the Inyo National Forest. Jeffrey pine beetle populations in the San Bernardino Mountains were low in 1996, and Jeffrey pine mortality was limited.

Lodgepole needleminer, *Coleotechnites milleri*

Region 5: Yosemite National Park

Host(s): Lodgepole pine

Population surveys indicate that populations of the lodgepole pine needleminer increased in 20 of 28 plots in the general vicinity of Tuolumne Meadows. If this trend continues, defoliation will be evident in the high-use zone around Tuolumne Meadows in 1998. Extensive areas west and north of Tuolumne Meadows are being defoliated by the third successive needleminer generation.

Mountain pine beetle, *Dendroctonus ponderosae*

Region 1: Idaho, Montana

Host(s): Lodgepole, ponderosa, and other pines

In 1996, mountain pine beetle populations increased by nearly half of their previous year's level throughout the region. In 1995, total for all host species was almost 37,000 acres infested. That figure increased to more than 53,300 acres in 1996. About 21,000 of those infested acres are in northern Idaho, on the St. Joe portion of the Idaho Panhandle National Forest. The remainder is in western Montana, with the most significant infestations being on the Lolo National Forest. Regionwide, an estimated 234,000 trees were killed by mountain pine beetle, most of them lodgepole pines. Beetle populations have taken advantage of favorable weather conditions over the past couple of years and an increasing amount of lodgepole pine, which is growing into more susceptible age classes in northern Idaho and western Montana. Populations remain quite active, and may be expected to increase on the Lolo National Forest in Montana

and also show indications of continuing to build on parts of the Idaho Panhandle National Forests.

Region 2: Colorado, South Dakota, Wyoming

Host(s): Limber pine, lodgepole pine, ponderosa pine

In Colorado, mortality continues to increase in ponderosa and lodgepole pine. Aerial survey results from 86 percent of Colorado identified 12,891 dead trees on 10,879 acres. Areas of concern include the Uncompahgre Plateau, Derby Mesa, Steamboat Lake State Park, the Vail Valley, the western foothills of the Arkansas Valley, the Frisco/Keystone area, Table Mountain and the Granby area, the Cache la Poudre/Redfeather Lakes area, Larkspur, and Buena Vista, where about 2,440 infested ponderosa pines and a few lodgepole pines, on 3,200 acres, were reported. The infestation near Buena Vista is expected to continue in 1997. The tri-county area of Summit-Grand-Eagle (Frisco/Keystone area) saw a 180 percent increase in mountain pine beetle activity in 1996 from 1995. A total 3,425 trees were infested in 1996. The populations are expected to increase. Along the Front Range of Colorado, a general increase of mountain pine beetle activity was reported in ponderosa pine. Activity of the mountain pine beetle on the Black Hills was very low. About 1,500 ponderosa pine trees were killed on 2,900 acres of the Black Hills in South Dakota and Wyoming. Mountain pine beetle activity associated with pine tussock moth defoliation on ponderosa pine declined for the third consecutive year near Edgerton, Wyoming. An area around Deer Mountain, south of Laramie, is still of concern. Statewide, mountain pine beetle activity increased slightly throughout Wyoming.

Region 3: Arizona, New Mexico

Host(s): Ponderosa pine

The area of forests showing tree mortality resulting from mountain pine beetle attacks increased from 570 acres in 1995 to 3,295 acres in 1996. Mountain pine beetle–killed trees were detected in Arizona on the Kaibab National Forest (40 acres) and the Grand Canyon National Park (2,195 acres), and in New Mexico on the Carson National Forest (15 acres) and Santa Fe National Forest (1,045 acres).

Region 4: Idaho, Nevada, Utah, Wyoming

Host(s): Limber pine, lodgepole pine, Jeffrey pine, ponderosa pine, whitebark pine.

Mountain pine beetle-caused mortality decreased from 41,700 trees in 1995 to 29,100 trees in 1996. In Utah, 17,300 trees were killed during 1996, opposed to 25,500 trees in 1995. Ponderosa pine was the primary host. The largest outbreak is located on the Dixie National Forest, where 8,500 trees were killed. Smaller outbreaks were located on most other national forests in Utah. In Idaho, mortality decreased with 11,400 trees killed in 1996 compared to 14,400 trees in 1995. Mortality occurred in both lodgepole and ponderosa pine. Decreases occurred on most national forests in the region. The largest outbreak in southern Idaho is located on the Targhee National Forest. Mortality of whitebark and limber pine attributed to mountain pine beetle infestation continued to increase in 1996. Small,

isolated infestations are located on national forests in Idaho, Utah, and on the Bridger-Teton National Forest in western Wyoming. Larger outbreaks are located on the Manti-LaSal National Forest in Utah, and the Targhee National Forest in Idaho.

Region 5: California

Host(s): Limber pine, lodgepole pine, ponderosa pine, sugar pine, western white pine, whitebark pine

Mortality from mountain pine beetle of all size classes of sugar pine still seems disproportionately high in comparison with other tree species in the Klamath Mountains. The lingering effects of drought and overstocking appear to be contributing factors.

In the Sierra Nevada, mortality remained high in lodgepole pine on the Truckee District, Tahoe National Forest. Most mortality is associated with riparian areas that are overstocked with 80- to 100-year-old lodgepole pine. Attacks continued on lodgepole pine in areas around Lake Tahoe, and low levels of mortality continued on the Mammoth Ranger District on the Inyo National Forest. The mountain pine beetle was associated with extensive limber pine mortality in the Dechambeau Creek drainage on the west side of Mono Lake on the Inyo National Forest, and there is considerable mortality to western white and whitebark stands above Lundy Canyon and around Mono Dome.

Region 6: Oregon, Washington

Host(s): Lodgepole pine, ponderosa pine, sugar pine, western white pine, Jeffrey pine.

Acres affected by mountain pine beetle decreased from 440,000 acres with an average of 2.07 trees/acre in 1995 to 169,260 acres with an average of 3.46 trees/acre in 1996. Decreased activity was detected in all host types, except sugar pine, which experienced a slight increase in total number of trees killed. Areas most heavily affected include the Deschutes, Fremont, Okanogan, and Winema reporting areas. Two normal years of precipitation have alleviated drought stress, although dense stand conditions continue to predispose areas to damaging mountain pine beetle infestations.

Pandora moth, *Coloradia pandora*

Region 6: Oregon

Host(s): Lodgepole pine, ponderosa pine

The current pandora moth infestation in central Oregon began in 1986 and grew with each successive generation until 1994, when pines on 369,100 acres were defoliated. A naturally occurring virus was noted throughout the infested area in 1994. We believe that this virus brought about the collapse of the pandora moth population since only 12,300 acres were defoliated in 1996.

The defoliation produced by the larvae has caused concern, but trees are only bare for a short time until the current year's growth of needles appears later in the summer. We anticipate the long-term effects of the infestation will be minimal, with very low tree mortality in some areas.

Pine engraver beetle, *Ips* spp.

Region 1: Idaho, Montana, Wyoming

Host(s): Lodgepole pine, ponderosa pine

Pine engraver (*Ips pini*) populations returned to nearly endemic levels throughout the region between 1995 and 1996. In 1995, as a result of unseasonably warm and dry weather in 1994, nearly 25,000 acres showed some level of pine engraver activity. In 1996, that figure was reduced to just over 100 acres region-wide. Favorable weather during spring 1996, and again during the winter of 1996-97, throughout usually susceptible lower elevation ponderosa pine stands in western Montana and northern Idaho, should result in continuing low populations of engraver beetles in 1997. Likewise, land managers are becoming increasingly aware of the need for proper slash management during late-winter and early-spring logging in ponderosa pine stands. That, too, is helping reduce losses to engraver beetles.

Region 2: Colorado, South Dakota, Wyoming

Host(s): Colorado blue spruce, lodgepole pine, pinon pine, ponderosa pine

Ips beetle activity along the Front Range of Colorado continued, with high levels of activity reported in the Black Forest. *Ips confusus* activity was reported in pinon pine on the western slope, particularly in areas west of Durango and south of Montrose, Colorado. *Ips hunteri* was reportedly responsible for urban Colorado blue spruce top and tree mortality in Denver, Greeley, and Colorado Springs. Small pockets of top kill and tree mortality continued to be present in ponderosa pine in the Black Hills. While in Wyoming, very little beetle activity was reported.

Region 3: Arizona, New Mexico

Host(s): Ponderosa pine

Ips beetle-killed trees were detected on 30,230 acres of the ponderosa pine forest cover type in 1996. Mortality occured on the Apache-Sitgreaves National Forests (100 acres), Coconino National Forest (475 acres), Coronado National Forest (170 acres), Kaibab National Forest (75 acres), Prescott National Forest (2,540 acres), Tonto National Forest (1,680 acres), San Carlos Indian Reservation (4,705 acres), and Fort Apache Indian Reservation (15,015 acres), Arizona. In New Mexico, 5,470 acres of *Ips* caused mortality were detected on State and privately owned lands in Mora and Cibola counties.

Region 4: Idaho, Nevada, Utah

Host(s): Lodgepole pine, ponderosa pine

Mortality due to pine engraver beetle (*Ips pini*) remained static throughout the region. Activity is often associated with western pine beetle. In Utah, populations were found in slash of ponderosa and lodgepole pine.

Region 5: California

Host(s): Pines

Activity of pine engravers was generally low in northern and north coastal California. In the Sierra Nevada, populations of the California five-spined ips remained highly active in the Volcano plantation, Tahoe National Forest, following extreme amounts of snow breakage in the spring of 1995. Suppression activities took place in the plantation. Pine engravers were not especially active in the central and southern Sierra Nevada, or in southern California. Activity in southern California was primarily in Coulter and pinyon pines. Black stain fungus or fire damage were contributing factors in pinyon pine mortality.

Region 6: Oregon, Washington

Host(s): Ponderosa pine

Pine engraver activity detected by air in 1996 was about 15 percent of 1995 levels. The majority of activity was detected on private lands in central and northeastern Oregon. Information from field locations in northeastern Oregon suggests that pine engraver beetle activity is more widespread than reported by aerial survey.

Region 8: Regionwide

Host(s): Loblolly pine, longleaf pine, shortleaf pine, slash pine

Three species of pine engraver beetles, *I. avulsus*, *I. calligraphus*, and *I. grandicollis*, were reported in 1996.

A prolonged drought in areas of east Texas resulted in an increase in pine engraver beetle activity. The number of scattered single trees, and occasionally clumps of trees being attacked and killed, increased, particularly in areas recently burned. There was a large number of pine engraver beetle infestations reported in Mississippi and Georgia but most were associated with the declining southern pine beetle populations.

Pine engraver beetle populations were extremely high in the panhandle of Florida and southern Alabama in counties affected by Hurricanes Erin and Opal in which widespread pine mortality has generated massive population increases. Similarly, the aftermath of Hurricanes Fran and Bertha continue to cause pine engraver beetle problems in piedmont and coastal North Carolina and Virginia that were aggravated by ice damage.

Pine sawflies, *Neodiprion* and *Diprion* spp.

Region 8: Florida, Tennessee

Host(s): Loblolly pine, longleaf pine, slash pine

For the third consecutive year, high populations of redheaded pine sawfly, *Neodiprion lecontei*, continued to cause noticeable to severe (75 to 100 percent) defoliation on longleaf and slash pines in areas of Central Florida (Lake, Marion, Polk, and Orange Counties). Relatively minor yet noticeable levels of tree mortality occurred in association with this defoliation. Some of the most seriously defoliated areas exhibited a high incidence of diseased/dead larvae in October, indicating a potential end to these sawfly problems. Areas of mature loblolly pine forest in Marion County experienced severe defoliation due to high populations of the blackheaded pine sawfly, *Neodiprion excitans*.

Meanwhile, feeding by the loblolly and Virginia pine sawflies was heavier than normal in middle and east Tennessee.

Roundheaded pine beetle, *Dendroctonus adjunctus*

Region 3: Arizona, New Mexico

Host(s): Ponderosa pine

Roundheaded pine beetle–caused tree mortality was detected on 9,340 acres of host type in 1996 compared to 29,900 acres in 1995. Mortality occurred in Arizona on the Coronado National Forest (20 acres), and in New Mexico on the Lincoln National Forest (4,305 acres) and Mescalero Indian Reservation (5,015 acres).

Region 4: Utah

Host(s): Ponderosa pine

Ponderosa pine mortality is being caused by this beetle on the Pine Valley Ranger District on the Dixie National Forest.

Southern pine beetle, *Dendroctonus frontalis*

Region 8: Alabama, Arkansas, Georgia, Florida, Mississippi, North Carolina, South Carolina, Texas, Virginia

Host(s): Loblolly pine, longleaf pine, slash pine, shortleaf pine

Southern pine beetle (SPB) populations declined dramatically from the recordsetting outbreak in 1995. In 1996, the number of SPB infestations (spots) decreased by 70 percent (from 57.5 thousand to 17.5 thousand spots). The number of affected acres decreased by 66 percent (from 21.7 million to 7.3 million acres). The number of beetle infestations decreased in every State except Tennessee.

Beetle populations still reached outbreak levels in parts of North Carolina, South Carolina, Georgia, Alabama, Tennessee, Mississippi, Louisiana, and Arkansas. The majority of the activity occurred in early part of 1996 as a carryover from the high levels of SPB activity in 1995.

Adverse environmental conditions, natural enemies, and intensified suppression efforts played a role in reducing SPB populations. Two to three weeks of extremely hot weather in September 1995 followed by two severe freezes in December 1995 and February 1996 (temperatures dropped over 50 degrees in a 24-hour period) helped reduce SPB populations throughout the South. Evaluation of SPB brood with the thin-barked shortleaf pine in February showed 50 to 75 percent mortality rates in Alabama. The buildup of populations of natural enemies also contributed to the demise of SPB populations. Finally, State and Federal officials were able to mobilize a more intensified effort in the suppression of SPB infestations and catch up with the backlog of uncontrolled infestations.

With regard to National Forest System lands, the area most seriously impacted was the Ouachita National Forest in Arkansas. More than 2,500 infestations were detected and over 2,900 thousand cubic feet of beetle-killed timber were salvaged. An area of special concern was the Caney Creek Wilderness, located near Mena, Arkansas. Eighty-eight SPB infestations occurred within the wilderness. Seven of these required control actions be conducted within the wilderness to protect adjacent private forested land.

On private land in South Carolina, 22 of the State's 46 counties started the year in outbreak status. However, in July, the Governor disbanded the forest disaster council, which had been formed in 1995 to expedite salvage of beetle-killed timber, due to the decrease in beetle activity. There was activity in northeast North Carolina. The SPB outbreak that had severely affected Gainesville and the northern part of Florida collapsed in early 1996. The situation was similar in the Gulf Coastal Plain of Alabama, Mississippi, and Louisiana.

SPB activity continued to remain low in east Texas, an area historically known to experience the most dramatic losses. The Texas Forest Service reported only 185 infestations and no outbreak counties.

Region 9/Northeastern Area: Delaware, Maryland, West Virginia

Host(s): Loblolly pine, pitch pine, Virginia pine

Aerial survey of 1995 damage areas in Delaware showed no damage in 1996. In West Virginia, the infestation collapsed and no damage was reported. No activity was reported in 1996 in Maryland.

Spruce beetle,
Dendroctonus rufipennis

Region 1: Idaho, Montana

Host(s): Engelmann spruce

Spruce beetle populations once again remained low throughout the region in 1996, though there was a slight increase in infested area in western Montana. In northern Idaho, only 68 infested acres were recorded. Most occurred as small and scattered groups of trees on the Idaho Panhandle and Nez Perce National Forests. In western Montana, 767 infested acres were recorded in 1995. That increased to just less than 1,300 acres in 1996. Most population increases were observed on the Flathead and Gallatin National Forests. A potentially serious outbreak condition exists on the Flathead National Forest, but plans are in place to remove infested down and fire-weakened trees before beetle populations infest nearby standing green trees.

Region 2: Colorado, Wyoming

Host(s): Engelmann spruce

Spruce beetle activity in the State of Colorado was minimal and occurred only in very isolated areas, that is, Forbes Trinchera Ranch south of Fort Garland, Colorado. Slight population increases were associated with spring blowdown in western Wyoming. Activity occurred in scattered patches containing only a few dozen trees.

Region 3: Arizona, New Mexico

Host(s) Engelmann spruce

Spruce beetle–caused tree mortality decreased from 1,240 acres in 1995 to 615 acres in 1996. Mortality was detected in Arizona on the Coconino National Forest (5 acres), Kaibab National Forest (270 acres), and in New Mexico on the Carson National Forest (80 acres), Gila National Forest (35 acres), Lincoln National Forest (35 acres), Santa Fe National Forest (145 acres), and the Mescalero Apache Indian Reservation (45 acres).

Region 4: Idaho, Utah, Wyoming

Host(s): Engelmann spruce

Spruce beetle mortality increased approximately threefold during 1996 with 82,500 trees recorded compared to 28,100 in 1995. No significant mortality was reported on any national forests in southern Idaho. In Utah where 81,400 trees were recorded, mortality increased on all national forests except the Ashley. Mortality was heaviest on the Dixie, Fishlake, and Manti-LaSal National Forests. No significant mortality was observed on the Bridger-Teton National Forest in western Wyoming.

Region 5: Northwestern California

Host(s): Sitka spruce

No activity was reported.

Region 6: Oregon, Washington

Host(s): Engelmann spruce

All reported spruce beetle–caused mortality in Oregon and Washington in 1996 was in Engelmann spruce. Reported number of trees killed increased from 6,900 in 1995 to over 31,800 in 1996. Over 90 percent of all trees killed were reported in the Pasayten Wilderness on the Okanogan National Forest. In other areas, spruce beetle activity was lightly scattered in the host type. Low levels of spruce beetle activity are due, in part, to the gradual removal of preferred host trees by previous infestations.

Region 10: Alaska

Host(s): Lutz spruce, Sitka spruce, white spruce

For the last 4 years, spruce beetle-caused mortality has been over 600,000 acres/year and building. The year 1996 has proven to be another record year, with spruce beetle infestation achieving the highest level on record in Alaska; about 1.1 million acres of active and newly infested areas were detected. Many ownerships are affected, with two-thirds of the infestations occurring on State and privately owned lands. The number of trees that died in 1996 from this infestation totalled over 30 million.

Active and Newly Infested Areas on Statewide Ownership

Ownership	Thousands of acres	Percent
State	321	28
Native	339	30
Private	97	9
Federal	374	33
Total	1,131	100

Active and Newly Infested Areas on Federal Ownership

Ownership	Thousands of acres	Percent
U.S. Fish And Wildlife Service	188	50
National Park Service	89	24
Bureau of Land Management	62	17
National Forest System	27	7
Military	8	2
Total	374	100

The most intense activity continues to be on the Kenai Peninsula, with 566,274 acres detected, and the Copper River area, with 154,134 acres detected. Many of these stands have 60 percent or more mortality. The beetle pressure in Anchorage, the largest populated area in Alaska, has increased to 33,100 acres.

In southeast Alaska, the Haines area experienced its seventh consecutive year of activity: 13,783 acres were detected on Alaska State lands and the infestation crosses the border into Canada. An outbreak affecting 9,500 acres occurred along Dall Island stretching north to Noyes Island in the southernmost tip of Alaska. Bark beetle outbreaks in the southeastern portion of Alaska tend to be short-lived and less destructive than outbreaks in south-central and interior Alaska due to the amount of rainfall and milder temperatures each year.

Region 9/Northeastern Area: Maine

Hosts: Red spruce, white spruce

Populations have showed considerable expansion from 1994 to 1996 on coastal islands of Maine. There are also pockets of infestation on mainland coastal areas mostly in Hancock County. There were 2,160 acres of spruce mortality reported and some islands have more than 50 percent mortality in white spruce over 10 inches diameter breast height (dbh). Spruce beetle on the coast tend to attack smaller trees than those attacked during the 1980's outbreak in northern Maine, in which many larger trees were killed. Also, the island environment is moist, and dead trees decay rapidly, limiting opportunities for salvage logging.

Spruce Budworm, *Choristoneura fumiferana*

Region 10: Alaska

Hosts: Lutz spruce, Sitka spruce, white spruce

Areas along the Yukon and Tanana Rivers in interior Alaska have seen their seventh consecutive year of budworm defoliation by *C. fumiferana* var. *orae*, and *C. biennis*. Research studies have shown that the defoliated trees have been significantly stressed. Some topkill and mortality is occurring in seedlings and saplings. In 1996, State and privately owned lands were most affected (149,248 acres) with 86,688 acres of Bureau of Land Management land carrying the balance. Since 1993, spruce coneworms (*Dioryctria reniculelloides*) were observed feeding in conjunction with spruce budworms and may be responsible for some of the defoliation attributed to budworms.

There is increasing concern that endemic engraver beetle (*Ips perturbatus*) populations in budworm-impacted areas may take advantage of the stressed trees and increase to outbreak proportions. Also of concern to biologists is the predicted crash in the red squirrel populations. Red squirrels are highly dependent on spruce cones for winter food. Interior spruce have not had a cone crop for almost 6 years in heavily defoliated areas.

Region 9/Northeastern Area: Maine, Michigan, Minnesota, New York, Pennsylvania, Vermont, Wisconsin

Host(s): Balsam fir, hemlock, white spruce

In Maine, populations of the spruce budworm have been monitored by field observations and trap catches. Larval occurrence and moth catch in light and pheromone traps have been consistently very low throughout

the 1990's, but landowners remain interested in the status of this pest because of its destructive potential. No defoliation and very few larvae were detected in 1996. However, moth catches increased slightly along the western and northern borders. Trapping was intensified in these areas in 1997. Defoliation decreased from 971 acres in 1995 to 366 acres on the Hiawatha National Forest in the Upper Peninsula of Michigan, but a new area of 12,553 acres was reported on Isle Royale. There was an overall decrease in area defoliated in Minnesota from 484,533 acres in 1995 to 207,588 acres in 1996, mostly on State and privately owned lands throughout the State. Damage on the Chippewa and Superior National Forests was considerably less than in 1995. In New York, the small area of infestation in Chautauqua County continued, with 10 acres reported. In St. Lawrence County, there was an increase in moth catch in pheromone traps used for monitoring. Defoliation in Pennsylvania occurred on about 2,000 acres of hemlock and balsam fir. Populations in Vermont remained at low levels with a small increase in moths caught in pheromone traps. No activity was reported in Wisconsin in 1996.

Western balsam bark beetle, *Dryocetes confusus*

See Subalpine fir mortality complex.

Western hemlock looper, *Lambdina fiscellaria lugubrosa*

Region 6: Oregon, Washington

Host(s): Douglas-fir, Pacific silver fir, Sitka spruce, western hemlock

Over 1,500 acres of hemlock looper defoliation were detected in 1996. The majority of the reported activity occurred on the Mt. Baker-Snoqualmie National Forest. No activity was reported in 1995.

Western pine beetle, *Dendroctonus brevicomis*

Region 1: Idaho, Montana

Host(s): Ponderosa pine

As was the case with other weather-dependent bark beetle species, the acreage of ponderosa pine stands infested by the western pine beetle also decreased in both northern Idaho and Montana in 1996. In northern Idaho, the decrease was from 8,000 acres in 1995 to fewer than 4,500 acres in 1996. Decreases occurred in virtually all reporting areas for which survey data was obtained. Most infestations were in widely scattered,

small groups throughout the ponderosa pine type. The decrease in western Montana was not as significant—down from 1,400 acres in 1995 to just less than 1,200 acres in 1996. Most infestations occurred in scattered groups on the Bitterroot and Lolo National Forests, the Flathead Indian Reservation, and in the Garnet Mountain Range east of Missoula.

Region 3: Arizona, New Mexico

Host(s): Ponderosa pine

Western pine beetle–killed trees were detected on 6,480 acres in 1996 compared to 1,910 acres of host type in 1995. Mortality was observed on the following Federal lands in Arizona: the Apache-Sitgreaves National Forests (1,510 acres), Coconino National Forest (55 acres), Kaibab National Forest (40 acres), Tonto National Forest (45 acres), and the Navajo Indian Reservation (70 acres). It was also noted in New Mexico on the Gila National Forest (4,755 acres).

Region 4: Idaho

Host(s): Ponderosa pine

Western pine beetle activity decreased on the Boise, Payette, and Sawtooth National Forests in southern Idaho. About 4,300 trees were killed in 1996 compared to 8,900 in 1995. Pine engraver beetle activity was frequently associated with western pine beetle infestation.

Region 5: California

Host(s): Coulter pine, ponderosa pine

In northwestern California western pine beetle has killed scattered ponderosa pines, particularly trees of large size, but the amount is less than in recent years. Mortality from western pine beetle is more common in the Southern Cascades and Modoc Plateau sections but is down considerably from 1994 and 1995. Mortality remained scattered in the northern Sierra Nevada and generally low in the central and southern Sierra Nevada.

In southern California, Coulter pines that died on Mt. Palomar (San Diego County) in the late 1980's and early 1990's at the end of a multiyear drought are now blowing down in substantial numbers.

Region 6: Oregon, Washington

Host(s): Ponderosa pine

Western pine beetle activity decreased substantially in both large and pole-sized ponderosa pines. Over 52,300 large trees were killed in 1995 compared to about 18,600 in 1996. Mortality in smaller, pole-sized trees decreased from 18,900 trees in 1995 to 12,400 trees killed in 1996.

Notable increases in large-tree mortality occurred on the Deschutes and Winema National Forests. In general, the rest of the region experienced an overall decrease in the reported acres affected by western pine beetles.

Western spruce budworm, *Choristoneura occidentalis*

Region 1: Idaho, Montana

Host(s): Douglas-fir, Engelmann spruce, true firs

In 1995, for the first time since aerial detection began in 1948, budworm-caused defoliation was not found. In 1996, again our aerial detection flights did not record any budworm defoliation in the region. This represents a major shift from recent years when it was common to have over a million acres defoliated every year. Pheromone trap counts were up by only a few moths over 1995. Populations are starting to rebuild following favorable climatic conditions last spring and summer but remain low. Defoliation is only expected in a few scattered areas where trap counts were above four or five moths per trap. Population recovery to pre-1994 levels may take several more years. No major increase is forecast for 1997.

Region 2: Colorado, Wyoming

Host(s): Douglas-fir, Engelmann spruce, blue spruce, true fir

Widespread defoliation of Douglas-fir, true firs, and spruce continued throughout the forests of southern Colorado. Douglas-fir and true fir mortality are common in areas that have been repeatedly defoliated for at least a decade. Defoliation was evident on about 20,000 acres of the Rio Grande National Forest. Defoliation has increased on the Uncompahgre Plateau of the Uncompahgre National Forest and on the Cochetopa Dome of the Gunnison National Forest. In the Salida area of Colorado, about 5,000 acres of infested private lands was reported by the State of Colorado; aerial detection survey showed 1,100 acres of severe defoliation over this area. Current-year defoliation in this area was in the moderate category. Areas between South Fork and Wagon Wheel Gap and north of Lake City have been noted for increased activity. No significant activity was reported in Wyoming in 1996.

Region 3: Arizona, New Mexico

Host(s): Douglas-fir, spruce, true firs

The area of forests defoliated by the western spruce budworm decreased region-wide from 190,855 acres in 1995 to 126,985 acres in 1996. In Arizona, defoliated acres decreased from 7,065 acres in 1995 to a total of 425 acres in 1996. Areas experiencing defoliation in Arizona included the Kaibab National Forest (425 acres). In New Mexico, defoliation decreased from 183,790 acres in 1995 to 126,560 acres in 1996. On Federal lands, defoliation occurred on the Carson National Forest (63,820 acres), Gila National Forest (240 acres), Lincoln National Forest (40 acres), Santa Fe National Forest (20,230 acres), Santa Clara Pueblo Indian Reservation (280 acres), and the Navajo Indian Reservation (2,645 acres). Defoliation on nonindustrial State and privately owned lands in northern New Mexico totaled 39,305 acres of susceptible mixed conifer host type.

Insects: Native

Region 4: Idaho, Utah, Wyoming

Host(s): Douglas-fir, true firs

No visible defoliation from spruce budworm was observed in the region during 1996.

Region 6: Oregon, Washington

Host(s): Douglas-fir, Engelmann spruce, true firs, western larch

Areas of visible defoliation decreased slightly from 190,000 acres in 1995 to 183,200 in 1996. Although there was a slight decrease in the number of reported acres affected, there was an observable intensification of the defoliation in the mapped areas.

The greatest increase in acreage affected occurred within the Yakama Indian Reservation. Areas of visible defoliation increased from 111,800 acres in 1995 to over 140,300 in 1996. An intensification of the defoliation was also recorded for this area.

Insects: Nonnative

A leafhopper,
Sophonia rufofascia

Region 5: Hawaii

Host(s): Numerous, including native plants on the endangered list.

This leafhopper affects at least 307 plant species, including some that are identified as endangered species. Recent studies indicate that mycoplasma-like agents are not involved in damage/death of the host; oviposition may be the primary cause. Parasitoids have been found and studies on relevance and impact are underway.

Asian long-horned beetle,
Anoplophora glabripennis

Region 9/Northeastern Area: New York

Host(s): Horse chestnut, maples, willow

In September 1996, this beetle was discovered in New York attacking trees in Brooklyn and in Amityville, Long Island. The beetle is native to Japan, Korea, and southern China and this was the first reported infestation in the United States. The USDA Animal and Plant Health Inspection Service (APHIS) has determined that the spread of this insect could result in significant impacts on urban, rural, and forest areas in North America. In December, New York initiated a quarantine restricting the movement of host materials in Brooklyn and Amityville. Eradication will be accomplished by chipping and burning the 1,200 infested trees.

Balsam woolly adelgid,
Adelges piceae

Region 1: Idaho

Host(s): Grand fir, subalpine fir

Balsam woolly adelgid populations continue to expand in northern Idaho. Infested acres estimated from aerial surveys has doubled from 1995 to over 24,000 acres in 1996. The figures for actual infested acres are probably higher because some areas are not yet displaying crown symptoms. Areas with the heaviest infestations occur on the Idaho Panhandle, Clearwater, and Nez Perce National Forests and adjacent State, private, and Bureau of Land Management land. Subalpine fir of all ages and size classes are killed. Extensive gouting and bole infestations occur on grand fir but only grand fir regeneration has suffered mortality. Regeneration mortality of both subalpine and grand fir is high, resulting in forest type conversions in some areas.

Region 6: Oregon, Washington

Host(s): True firs

Balsam woolly adelgid activity was observed on 13,700 acres in 1996, a decrease of 700 acres from 1995 reported levels. Although there was a slight decrease in the acres reported in 1996, the total number of trees killed increased from 12,200 in 1995 to approximately 16,200 in 1996. The majority of activity was reported in wilderness areas of the Mt. Baker-Snoqualmie National Forest and Mt. Rainier and Olympic National Parks.

Region 8: North Carolina, Tennessee, Virginia

Host(s): Fraser fir

Fraser fir has a limited range and occurs predominantly on the highest mountains of the southern Appalachians. This forest type occurs in pure stands on the highest peaks or in a mixture with red spruce at lower elevations. Since the introduction of the balsam woolly adelgid, 64,700 acres of Fraser fir have been affected. The insect prefers larger fir trees, which has led to the demise of almost all mature host trees within the affected areas. Adelgid populations were high again in 1996.

Region 9/Northeastern Area: Maine, West Virginia

Host(s): Balsam fir, Fraser fir

Increased activity was reported in central Maine. Surveys continued in West Virginia and mortality of a small number of trees was found.

Blue gum psyllid, *Ctenarytaina eucalypti*

Region 5: Central and Southern California

Host(s): Blue gum and *Eucalyptus pulverulenta*.

First found in 1991, this psyllid is now widespread and occurs in all coastal California counties except Del Norte. The primary parasitoid wasp, *Psyllaephagus pilosus* Noyes (Encyrtidae), appears to be spreading rapidly.

Common European pine shoot beetle, *Tomicus piniperda*

Region 9/Northeastern Area: Illinois, Indiana, Maryland, Michigan, New York, Ohio, Pennsylvania, West Virginia

Host(s): Scotch pine, white pine

The common European pine shoot beetle was discovered near Cleveland, Ohio, in 1992. It has now been found in eight States and Ontario, Canada. State and Federal quarantines are in effect to prevent the spread of the insect to new areas, but, the beetle was found in 65 new counties in 1996.

Gypsy moth—Asian,
Lymantria dispar

Region 6: Washington

Host(s): Oaks, apple, sweetgum, other hardwoods

Of the 173 gypsy moths trapped in 1996, one was identified as the Russian Far East strain. Also, one Asian gypsy moth larva was found at a port facility where the adult was subsequently caught. An eradication project is planned for 1997.

Region 8: North Carolina, South Carolina

Host(s): Alder, larch, oak, poplar, willow, other hardwoods, some evergreens

In 1993, adult Asian gypsy moths with their characteristic flying females were accidentally released at the Military Ocean Terminal at Sunny Point, North Carolina. Hundreds of male moths (European strain, Asian strain, and hybrids) were captured in pheromone traps after the accidental introduction. The Asian gypsy moth could cause more serious economic and environmental consequences due to its wider range of host species and ability to disseminate through flying. Therefore, a cooperative eradication project with the North Carolina Department of Agriculture and APHIS was initiated in 1994 to deal with this accidental introduction. Some 143,000 acres were treated twice with *Bacillus thuringiensis* (*Bt*) and with the gypsy moth virus applied to sensitive areas during 1994. Trapping throughout a 1,600-square-mile area on the North Carolina–South Carolina border in 1994 and 1995 revealed several Asian gypsy moths in pheromone-baited traps. Although the 1994 eradication effort was considered largely successful, supplemental spraying of *Bt* was conducted in 1995 (6,340 acres) and in 1996 (1,490 acres) to completely eliminate Asian gypsy moth from the area. Trapping across a 1,000-square-mile area in 1996 did not yield any further captures of Asian moths and there are no plans for further treatment in 1997. The post-treatment evaluation will continue in 1997 to confirm that the infestation is eradicated, but it will be scaled down to include trapping over a 100-square-mile core area only.

Gypsy moth—European
Lymantria dispar

Region 1: Idaho, Montana, North Dakota, Wyoming

Host(s): Hardwoods

Cooperative detection monitoring for the gypsy moth with APHIS, State Departments of Agriculture, Forestry, and Lands continued in 1996. A network of strategically located pheromone-baited traps were placed throughout all States in the region. In 1996, no gypsy moths were caught on Federal lands, but moths were caught on other ownerships in Montana. Six moths were trapped in Missoula, Montana; five in one trap and one in another 1 mile away. Intensive delimitation surveys are planned in Missoula in 1997.

Region 2: Colorado, Kansas, Nebraska, South Dakota, Wyoming

Host(s): Hardwoods

Surveys continue region-wide on State, private, and Federal lands. In Colorado, a total of 1,799 detection traps were deployed. An additional 153 delimitation traps were placed surrounding the previously positive traps' sites. A total of four moth catches were made in detection traps in 1996, one per site in the following areas: Denver, Lafayette, Northglenn, and Hotchkiss. The delimitation trapping caught no moths. Delimitation trapping will be done around all 1996 catches. Detection trapping was expanded to include additional Federal sites. In Wyoming, a total of 554 detection traps were deployed. An additional 80 delimitation traps were placed surrounding the previously positive trap sites. Single moth catches were made in Cody, Jackson, and Sheridan. In 1996, delimitation trapping caught no moths in Wyoming. On Warren Air Force Base in Cheyenne, 1 trap caught 8 gypsy moths and an adjacent trap caught 3 moths; an additional single catch was made nearby, for a total of 12 moths caught on the base. This is the most gypsy moths ever caught in 1 year in Wyoming. An extensive delimiting survey is planned in 1997 on Warren Air Force Base, as well as around the three other single catches. In South Dakota, 4 moths were caught from 697 detection traps. Moths were caught in Meade and Pennington Counties. In Nebraska, four moths were caught: two in Omaha and one each in South Sioux City and Harlan Co.

Region 3: New Mexico

Host(s): Hardwoods

Two adult male gypsy moths were captured in pheromone traps in New Mexico in 1996. These moths were captured in a campground on private land in Tucumcari, Quay County, NM.

Region 4: Idaho, Nevada, Utah

Host(s): Various deciduous species

Seven moths were caught in Salt Lake County, Utah. All moths were captured in the foothills of areas previously treated during the eradication project. A delimitation and mass trapping program will be undertaken in the summer of 1997. Four moths were caught in Nevada and a delimitation program is also planned. For the first year since the trapping program in Idaho began in 1986, no moths were caught during 1996. Detection trapping will continue throughout the region.

Region 5: California

Host(s): Many different trees and ornamentals

Gypsy moths were detected in seven counties in 1996: Alameda, Del Norte, Los Angeles, Marin, Mariposa, Monterey, and Nevada. Nevada County was the most significant detection; 29 moths were trapped and 1 property was found with live females, pupae, pupal cases, and cast skins.

Two eradication treatments were initiated for life stage finds in 1995, one in Felton, Santa Cruz County, and another in Grass Valley, Nevada County. *Bacillus thuringiensis* (*Bt*) was the material used. Post-treatmen t

monitoring has not produced any further moth captures in the two areas. The captures in Nevada County in 1996 were in Penn Valley.

Region 6: Oregon, Washington

Host(s): Oaks, apple, sweetgum, other hardwoods

Although no defoliation has been observed in either State, pheromone traps continue to catch moths. These catches represent either new introductions or populations not completely eradicated by previous treatments. In Washington, eight eradication projects totaling 21,856 acres were conducted using ground and aerial applications of *Bacillus thuringiensis* (Bt). In two of the ground application sites, diflubenzuron was also used in the immediate area where egg masses were found. The gypsy moth survey in 1996 resulted in trap catches of 173 individuals. Of those, one has been identified as the Russian Far East strain of the Asian gypsy moth, and the remainder were identified as the European strain. Eradication projects are planned for 1997 at the Asian gypsy moth site and four other sites where European gypsy moths were caught.

In Oregon, an eradication project was conducted in Multnomah County using two ground applications of *Bacillus thuringiensis* (*Bt*) on 10 acres. Forty-two moths were trapped in Oregon, and all have been identified as the European strain. Thirty-four of the catches were at one site at a U.S. Army Corps of Engineers campground in Lane County. A 70-acre eradication project there (aerial application of *Bt*) is planned for 1997.

It is expected new introductions will continue as long as moth populations in the East persist and people move from the generally infested area to the Pacific Northwest.

Region 8: Arkansas, Georgia, North Carolina, South Carolina, Tennessee, Virginia

Host(s): Apple, oaks, sweetgum, other hardwoods

No noticeable defoliation occured in Virginia during 1996, as compared to 849,000 acres of defoliated host type in 1995. The fungal pathogen *Entomophaga maimaiga* caused widespread collapse of populations over the generally infested portions of Virginia. Due to the collapse, the State plans to treat fewer than 100 acres in 1997—a significant decrease from the 120,000 acres treated in 1995 or the 14,926 acres treated in 1996.

Treatments to slow the spread of gypsy moth continue to be implemented along the expanding front in the 7-million-acre Slow-the-Spread (STS) pilot project area in the States of North Carolina, Virginia, West Virginia, and Michigan. During 1996, a total of 32,477 acres were treated as part of STS; 1,100 acres of private lands in North Carolina, 10,644 acres of private land in Virginia, 16,750 acres of private land in West Virginia, and 3,888 acres of National Forest System lands in Virginia and West Virginia. About 58 percent of the area was treated with *Bacillus thuringiensis* (*Bt*), 38 percent of the area with a mating disruptant specific to the gypsy moth, and 4 percent with the insect growth regulator, diflubenzuron.

Elsewhere, there were isolated infestations in northern Georgia (Fannin County, 800 acres), western North Carolina (Yancey County, 2,032 acres),

and eastern Tennessee (Unicoi County, 252 acres). Eradication projects were initiated on the listed acreages in each of these areas in 1996. Followup trapping was continued on the 1993-95 gypsy moth eradication project in north-central Arkansas. Only a limited number of male moths were caught. Trapping will continue, but no treatments are planned in 1997.

Region 9/Northeastern Area: Connecticut, Delaware, Illinois, Indiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia, Wisconsin

Host(s): Apple, aspen, basswood, black walnut, northern red oak, pin oak, red oak, southern red oak, white oak

About 4,000 acres were defoliated in three counties in Connecticut (aerial surveys indicated 1,400 acres severely defoliated). Egg mass surveys were conducted and showed only one site with any appreciable quantity. Aerial survey detected 534 acres of defoliation in Delaware, considerably less than the 150,000 acres reported in 1995. Moths were caught in traps in Illinois but no damage occurred. There was extensive trapping in Indiana where numbers of moths caught were up slightly from last year, but there was no damage reported. In Massachusetts, the presence of the fungus *Entomophaga maimaiga* reduced the severity of the infestation statewide. About 7,000 acres of defoliation was reported. Defoliation in Maryland was lower in 1996 occurring on 11,332 acres. Populations are at endemic levels in Maine and only 100 acres of defoliation were reported in the northern part. In Michigan, defoliation dropped from more than 85,000 acres to under 5,000 acres in 1996, but 15,000 acres of mortality in oaks due to gypsy moth was reported. Traps in Minnesota produced some moths but no damage was reported. In Missouri, 11,499 traps were placed, but very few moths were caught. No caterpillars or new egg masses were found in New Hampshire but an area of 400 acres where there have been repeated gypsy moth infestations is showing dead branches and dieback in red oak and other hardwoods. In New Jersey, area of defoliation dropped slightly to 27,755 acres. New York reported 16,285 acres of defoliation. Levels in Ohio increased somewhat to about 50,000 acres of defoliation. Area affected in Pennsylvania dropped to 6,715 acres in 1996 from over 129,000 acres in 1995. Rhode Island reported defoliation scattered over 4,000 acres. In Vermont, populations began building, but no defoliation was detected. Larval mortality was high and the fungus *Entomophaga* was present. Egg mass levels were reported to be low. Over 98,000 moths were caught in traps in Wisconsin, but no defoliation was reported. West Virginia reported 70,726 acres of defoliation, down from 102,000 acres reported in 1995.

Treatments to slow the spread of gypsy moth continue to be implemented along the expanding front in the 7-million-acre Slow-the-Spread (STS) pilot project area in the states of North Carolina, Virginia, West Virginia, and Michigan. During 1996, a total of 32,477 acres were treated as part of STS; 1,100 acres of private lands in North Carolina, 10,644 acres of private land in Virginia, 16,750 acres of private land in West Virginia, and 3,888 acres of National Forest System lands in Virginia and West Virginia. About 58 percent of the area was treated with *Bacillus thuringiensus* (*BT*), 38 percent of the area with a mating disruptant specific to the gypsy moth, and 4 percent with the insect growth regulator, diflubenzuron.

Hemlock woolly adelgid,
Adelges tsugae

Region 8: Virginia, North Carolina

Host(s): Hemlock

The hemlock woolly adelgid was first reported in the United States in 1920 on the West Coast. A second introduction occurred on the East Coast near Richmond, VA, in 1950. The insect has successfully colonized eastern hemlock, causing mortality within 3 to 5 years. The hemlock woolly adelgid threatens the entire range of eastern hemlock. Most of the hemlock type in Virginia is generally infested, except for southwestern counties; decline and mortality are extensive. Much of the hemlock resource is located in riparian areas and makes the impact of this insect pest significant and devastating. In 1995, the adelgid was discovered in North Carolina and now infests hemlock in Stokes, Surry, Rockingham, and Forsyth Counties, the latter two having been added in 1996.

Region 9/Northeastern Area: Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, West Virginia

Host(s): Eastern hemlock

The hemlock woolly adelgid infestation did not expand to any new counties in the region in 1996, but it continued to infest hemlock in the same areas as 1995. The range of the infestation begins in Massachusetts, affecting most of the State and extends southwest including all counties in Connecticut and Rhode Island, southeastern New York and Pennsylvania, all of New Jersey, northern Delaware, north-central Maryland, and eastern West Virginia. New sites were detected in Massachusetts but they were in previously infested counties. New York reported mortality of 91 hemlocks and other trees affected by defoliation, dieback, and decline. Discoloration was reported on 800 acres of hemlock in Rhode Island.

Larch sawfly,
Pristiphora erichsonii

Region 10: Alaska

Host(s): Eastern larch

Larch sawfly activity in interior Alaska increased from 116,000 acres of heavy defoliation in 1995 to nearly 607,000 acres in 1996. Defoliation occurred all along the Tanana River from Big Delta to Fairbanks to its confluence with the Yukon River. Ownerships affected are 37 percent Bureau of Land Management land, and 63 percent State and private land. Little or no mortality is occurring; however, there is the concern that four consecutive years of defoliation may be followed by a build-up of larch beetle (*Dendroctonus simplex*).

Spruce aphid,
Elatobium abietinum

Region 3: Arizona, New Mexico

Host(s): Spruce

The spruce aphid was first reported in the Southwest in late 1988 on the Fort Apache Indian Reservation located in the White Mountains of Arizona. At that time, about 100 acres of Engelmann spruce were defoliated. Later that same winter, 1989, insects and defoliation were also observed on ornamental spruce in Santa Fe, New Mexico.

In the winter of 1989-90, defoliation occurred again at Fort Apache and was reported later that year by local foresters. They noted that defoliation of Engelmann spruce was widespread throughout the lower elevation range of this species and estimated that up to 100,000 acres might be affected. In summer 1990 the affected area was visited. Although no aphids were found, defoliation was observed along with some discoloration, presumably caused by aphids feeding on live needles on spruce in the area. Defoliation, although noticeable on the ground, was not detectable from low-flying aircraft during annual detection survey that summer after new foliage had expanded.

In 1990 and 1991, low populations and light defoliation were observed in Santa Fe, New Mexico. No tree mortality was reported in any of these cases, defoliation was reported to be heaviest on understory trees.

The aphid then went undetected until the winter of 1995-1996, which was very mild and dry, a condition reported to favor outbreak development. At that time, populations and defoliation increased to spectacular levels in the White Mountains, Arizona. Defoliation was observed on both the reservation and on adjacent Apache-Sitgreaves National Forest lands. Defoliation was detected on 10,782 acres during aerial survey, but the total affected acres would be greater than that because light defoliation levels are difficult to see from the air. Some mortality has been reported from the reservation. All size classes of spruce were affected, including large overstory trees.

The defoliation appeared heaviest in the lower elevation ranges where Engelmann spruce occurs mixed with Douglas-fir, white fir, and ponderosa pine. In December 1996, specimens were collected from both Engelmann and blue spruce (*Picea pungens*) and sent to the USDA Systematic Entomology Lab for determination. The identification of the spruce aphid was confirmed by Gary Miller. Interestingly, only a few aphids and no defoliation were observed on blue spruce, a host that can be heavily defoliated in ornamental situations.

It is unclear whether the recent discovery of the insect and the more extensive defoliation is just associated with recent unusual weather events (severe drought and warm winter conditions) or reflective of a developing problem. Meanwhile, foresters at Fort Apache Indian Reservation are becoming increasingly concerned about potential effects of the organism.

Diseases: Native

Annosum root disease, *Heterobasidion annosum*

Region 1: Idaho, Montana

Host(s): Douglas-fir, grand fir, ponderosa pine, subalpine fir, western hemlock

Annosum root disease is common in ponderosa pine stands on the Flathead Indian Reservation and in other western Montana locations. It is widespread on Douglas-fir and true firs on the Clearwater, Nez Perce, and the Idaho Panhandle National Forests in Idaho.

Region 2: Colorado, Nebraska

Host(s): Jack pine, ponderosa pine, white fir

Annosum root disease has scattered distribution in white fir in the mixed conifer cover type throughout southern Colorado. In campgrounds, the disease creates hazardous conditions by increasing the probability of tree failure. In 1996, the disease was discovered in Vallecito Campground, Columbine Ranger District, San Juan National Forest. A sanitation removal project was implemented at the Amphitheater Campground, Ouray Ranger District, Uncompahgre National Forest.

Region 3: Arizona, New Mexico

Host(s): Ponderosa pine, true firs

Root diseases and their associated pests are responsible for about one-third of the conifer mortality region-wide. *Heterobasidium annosum* accounts for about 20 percent of this mortality. During surveys conducted on the North Kaibab Ranger District, the fungus was found in approximately 1 percent of the standing live trees.

Region 4: Location: California, Idaho, Nevada, Utah, Wyoming

Host(s): Bitterbrush, chokecherry, Douglas-fir, Jeffrey pine, lodgepole pine, ponderosa pine, spruce, true firs

Heterobasidium annosum can be found throughout the region, but mostly as a decay organism. The fungus is occasionally damaging to young, planted stands of ponderosa pine on droughty soils.

Region 5: California

Host(s): Conifers, some hardwoods

Heterobasidion annosum is the most widespread and damaging root disease agent in California. Annosum root disease and the fir engraver beetle (*Scolytus ventralis*) reduce growth and kill true firs in white fir and mixed-conifer stands on over a million acres in the Sierra Nevadas. Over 1.5 million acres of eastside ponderosa pine, ponderosa and Jeffrey pine, juniper, and other species are failing to meet forest health objectives because of annosus root disease and western and mountain pine beetles. The

disease is particularly damaging in stands that are partially cut because fresh cut stump surfaces can serve as entrance points for the fungus.

Region 6: Oregon, Washington

Host(s): Ponderosa pine, true firs, western hemlock

Annosum root disease causes losses in many partially cut white and grand fir stands in southern and eastern Oregon and eastern Washington. Mortality was high where annosum root disease and fir engraver beetles operate as a complex. The new regional vegetation inventory requires examination of cut stumps. This has led to increased reporting and awareness of annosum root disease on many national forests. In eastern portions of the region, where many stands were cut 10-20 years ago, trees surrounding cut stumps are dying. The disease's severity is expected to increase with time. Annosum root disease was observed with increasing frequency in stands that are predominantly ponderosa pine on drier sites in eastern Washington and Oregon. Reports of the disease in mountain hemlock and Pacific silver fir in high-elevation stands in the Cascade Range are also increasing. Annosum root disease in low-elevation western hemlock stands primarily causes butt rot. Impacts are considered low unless stands are managed at rotations greater than 120 years.

Region 8: Regionwide

Hosts: Southern pines (loblolly, slash, shortleaf, longleaf) and eastern white pine

Annosum root disease continues to cause significant losses of its pine host in the region. Mortality and growth losses range from 2 to 25 percent of growing stock volume of managed high risk stands across the South. The disease is most often associated with thinned pine plantations on sandy, well-drained sites but can be found on a variety of sites, soils, and forest conditions. Bark beetle infestations frequently occur within infected stands. In 1996, significant new areas of infection were discovered in South Carolina outside the traditional sandhill areas where infection is worst. Most of these areas were in the coastal plain.

Armillaria root disease, *Armillaria ostoyae*

Region 1: Idaho, Montana

Host(s): Douglas-fir, other conifers

Armillaria root disease is widely distributed in northern Idaho and western Montana. The apparent increase of this root disease in parts of this region is attributed, in part, to the increase in Douglas-fir and true firs resulting from fire control and selective harvesting of high-value pine and western larch early in the 20th century. It is also a major cause of mortality in young ponderosa pine plantations (15-25 years old).

Region 2: Colorado, South Dakota, Wyoming

Host(s): Engelmann spruce, hardwoods, lodgepole pine, ponderosa pine, subalpine fir, white fir

Armillaria root disease is easily the most common and damaging of the root diseases in the region. *Armillaria ostoyae* has been identified as present on 10 different tree hosts in Colorado, South Dakota, and Wyoming. The disease is commonly associated with the decline of subalpine fir caused by several bark beetles (Scolytus/Dryocoetes) throughout Colorado and Wyoming. Subalpine fir damage caused by this complex is particularly high at Aspen Mountain, Crested Butte and Powderhorn Ski Areas; on the White River National Forest, in areas including Basalt Mountain, Burnt Mountain, and Kobey Park; on the Uncompahgre Plateau at Ouray Springs; and on white fir in the San Juan National Forest.

Region 3: Arizona, New Mexico

Host(s): Aspen, Douglas-fir, ponderosa pine, spruce, true firs

Armillaria spp. account for about 80 percent of root disease mortality across the region. A greater percentage of the mixed conifer and spruce-fir forests are infected compared to ponderosa pine type. The southwestern region is working to determine the occurrence and effects of armillaria and other root diseases in southwestern forests. During surveys conducted on the North Kaibab Ranger District armillaria was found in approximately 30 percent of the standing live trees.

Region 4: Idaho, Nevada, Utah, Wyoming

Host(s): Douglas-fir, grand fir, pines, spruce, subalpine fir

Armillaria root disease is found throughout the region, functioning primarily as a weak pathogen or saprophyte causing little direct mortality. In southern Utah, it may act as a primary pathogen, killing mature and immature ponderosa pine and mature fir and spruce.

Region 5: California

Host(s): Conifers, some hardwoods

In California forests, the armillaria fungus is primarily a saprophyte or weak pathogen. It is more damaging in landscape settings, commonly killing oaks, other hardwoods, shrubs, and conifers that are irrigated or planted off-site.

Region 6: Oregon, Washington

Host(s): Conifers

The most serious losses from this disease occurred east of the Cascade Range in mixed conifer stands. Mortality continues in both disturbed and undisturbed stands, indicating one or more especially virulent strains of the fungus. True firs and Douglas-fir sustain the most losses. However, in localized areas, ponderosa pine mortality was significant. In mid- to high-elevation stands in the Cascades of southwestern Oregon, armillaria root disease causes mortality of several conifer species. Mortality on lower slopes west of the Cascades and in the Coast Range was usually confined

to younger, stressed trees. Assessing species resistance on a site-by-site basis and discriminating for the more resistant species during stand management activities are considered the most effective means of controlling spread and mortality.

Black stain root disease, *Leptographium wageneri*

Region 1: Idaho, Montana

Host(s): Douglas-fir, lodgepole pine, ponderosa pine

Black stain root disease is less common than other root pathogens and its importance in this region is largely unknown.

Region 2: Colorado

Host(s): Pinon pine, ponderosa pine

Black stain root disease continues as a problem on pinon pine in the southwestern corner of Colorado. Recent mortality was detected on private land near Colona, Colorado. The disease is a concern in recreation areas near McPhee Reservoir and at Mesa Verde National Park.

Region 3: New Mexico

Host(s): Pinyon pine, Douglas-fir

Both *Leptographium wageneri* var. *wageneri*, which infects pinyon, and *L. wageneri* var. *pseudotsugae*, which infects Douglas-fir, are rare in the Southwestern Region. The former is confined to two isolated areas in northern New Mexico, and the latter has been observed only in sites in south-central New Mexico.

Region 4: Idaho, Nevada, Utah

Host(s): Pinyon pine

This fungus causes mortality of pinyon pine on the Bureau of Land Management's Burley District in Idaho, on the Humboldt and Toiyabe National Forests in Nevada, and on the Dixie and Manti-LaSal National Forests in Utah.

Region 5: California

Host(s): Douglas-fir, Jeffrey pine, pinyon pine, ponderosa pine

Black stain root disease kills Douglas-fir, particularly saplings and pole sized trees in plantations, throughout Northwestern California. The disease is often associated with disturbance, such as thinning, often in areas with compacted soil. Mortality on thousands of acres of pinyon pine in Southern California, and ponderosa pine in northeast California, is also caused by black stain and associated insects.

Region 6: Oregon, Washington

Host(s): Douglas-fir, ponderosa pine

In southwestern Oregon, black stain root disease was the most commonly encountered disease in Douglas-fir plantations. High-risk areas are considered to be those where disturbances, such as road building or soil compaction, have occurred or where road maintenance equipment injured roadside Douglas-firs. Infected larger individuals were found scattered in previously entered forest stands. Black stain root disease continues to be observed on ponderosa pine east of the Cascades. Best management practices need to be determined to reduce disease incidence and severity.

Dwarf mistletoes, *Arceuthobium* spp.

Region 1: Idaho, Montana

Host(s): Douglas-fir, lodgepole pine, ponderosa pine, western larch

Lodgepole pine dwarf mistletoe infects approximately 2 million acres (28 percent) of the lodgepole pine type in the region and causes about 18 million cubic feet of growth reduction annually. Dwarf mistletoe is locally heavy in ponderosa pine stands around Lake Coeur d'Alene and along the Spokane River drainage in northern Idaho. Douglas-fir dwarf mistletoe infects about .6 million acres (13 percent) of Douglas-fir, reducing growth by approximately 13 million cubic feet annually. Western larch dwarf mistletoe occurs on about .8 million acres (38 percent) of western larch stands, and reduces annual growth by over 15 million cubic feet.

Region 2: Colorado, Wyoming

Host(s): Lodgepole pine

Dwarf mistletoes cause the greatest disease losses in the region. Losses equal at least 10 million cubic feet annually. In Colorado, 50 percent of the lodgepole pine type is infested with lodgepole pine dwarf mistletoe (*A. americanum*). Presuppression surveys and silvicultural control were conducted on six national forests. Continuing emphasis is being placed on surveys at landscape scale and on suppression projects in developed recreation sites.

Region 2: Colorado

Host(s): Douglas-fir

Douglas-fir dwarf mistletoe (*A. douglasii*) occurs mostly in the southern two-thirds of Colorado. A control project was carried out on the Salida Ranger District, San Isabel National Forest. Areas of management concern are; Columbine Ranger District, San Juan National Forest; Mountain Lion Lookout area, Saguache Ranger District, Rio Grande National Forest; and Long Creek on the Uncompahgre Plateau, Uncompahgre National Forest.

Diseases: Native

Region 2: Colorado

Host(s): Ponderosa pine

Losses from the dwarf mistletoe, *A. vaginatum* subsp. *cryptopodium* amount to 885,000 cubic feet annually. Suppression projects emphasized tree removal and pruning of infested trees in developed recreation sites. Silvicultural control projects were carried out on the Southern Ute Reservation and the Salida Ranger District, San Isabel National Forest. Private landowners in the Black Forest and along the Front Range of Colorado are reporting concerns as a consequence of newly established residences in infested areas.

Region 3: Arizona, New Mexico

Host(s): Pines, Douglas-fir, spruce, true firs

Dwarf mistletoes are the most significant disease-causing organisms in the Southwestern Region. Over 1 million acres of national forest commercial timberlands in each State have some level of dwarf mistletoe infection. Several hundred thousand additional infected acres occur in noncommercial and reserved areas, woodlands, and other public and private forest lands. There is some evidence that the incidence of dwarf mistletoe on ponderosa pine has increased in recent decades. This increase is likely a result of fire suppression (fire being the primary natural control agent) and selective cutting.

Region 4: Idaho, Nevada, Utah, Wyoming

Host(s): Douglas-fir, pines, western larch

Suppression projects continue to remove infected overstory trees; however this forest disease remains the most widespread and frequently observed disease within the Intermountain Region. Regional incidence by major host species is estimated as follows: lodgepole pine, 50 percent; ponderosa pine, 20 percent; and Douglas-fir, 20 percent infected. These numbers represent the percentage of host stands sharing some level of infection.

Region 5: California

Host(s): Douglas-fir, pines, true fir

Dwarf mistletoes are infesting conifers on approximately 25 percent of the forested land in California with over 4 million acres of national forest system lands affected. The distribution of dwarf mistletoe has not changed significantly over the past 30 years. Infections are slowing tree growth, contributing to tree mortality, and altering forest successional patterns. Western dwarf mistletoe continues to be a serious problem in recreation areas in southern California. Red fir dwarf mistletoe, along with *Cytospora* canker, is causing branch flagging and tree decline in red fir stands throughout its host range.

Region 6: Oregon, Washington

Host(s): Conifers

Dwarf mistletoes are present on approximately 9.5 million acres of forested lands in the Pacific Northwest Region. Their status changes little from year to year. However, long-term impacts, including reduced growth,

mortality, deformity, and top-kill, are significant, particularly in unmanaged stands. All conifer species are affected to some degree. Douglas-fir dwarf mistletoe is abundant east of the Cascades and in southwestern Oregon. Western larch dwarf mistletoe causes significant effects in northeastern Oregon and central and eastern Washington. The intensity of dwarf mistletoes in eastern Oregon and Washington is closely related to fire ecology. Lack of frequent, periodic fire in the last century has allowed infection levels to increase on many sites, especially those where mistletoe was not culturally controlled.

Region 10: Alaska

Host(s): Western Hemlock

Hemlock dwarf mistletoe (*A. tsugense*) is the most important disease of western hemlock in unmanaged, old-growth stands throughout southeastern Alaska as far north as Haines. The incidence of dwarf mistletoe varies from stands in which almost every western hemlock tree is severely infected to other stands in which the parasite is absent. Heavily infected trees have branch proliferations (brooms), bole deformities, reduced height and radial growth, less desirable wood characteristics, top-kill, and severely infected trees may die. These are all potential problems in stands managed for wood production; however, the disease also creates a greater diversity of forest structure and contributes unique wildlife habitat.

Region 9/Northeastern Area: Maine, New Hampshire, New York, Vermont

Hosts: Black spruce, red spruce, white spruce

Eastern dwarf mistletoe, *A. pusillum*, continued to cause severe damage in white spruce in coastal areas and islands of Maine. It also continued to occur on black and red spruce in inland bogs and forests and the trend for infection is expected to be upward. Red and black spruce in the mountains of New Hampshire, Vermont, and northern New York were also affected.

Fusiform rust,

Cronartium quercuum f. sp. *fusiforme*

Region 8: Florida, Georgia, North Carolina, South Carolina, Virginia

Host(s): Loblolly pine, slash pine

Fusiform rust is the most damaging disease of loblolly and slash pines in the South. Other pine species may also be infected, but little mortality or damage occurs. An estimated 13.4 million acres of loblolly and slash pine have infection levels greater than 10 percent. Georgia has the most disease with 4.6 million acres with 10 percent or more infection; 49 percent of the total host type for this State.

In South Carolina, new areas of severe fusiform rust were discovered in 1996. Because these areas are not highly rated for susceptibility to the disease, it is believed the cause is inordinate genetic susceptibility.

Heart rot,
many *Basidiomycetes*

Region 10: Alaska

Host(s): All tree species

Heart rot causes more economic loss than all other diseases in Alaska. Roughly 30 percent of the old-growth timber volume in southeast Alaska is defective because of heart rot fungi. In interior and south-central Alaska hardwoods, substantial volume loss can be expected in stands 80 years old or older. Sap rot decay routinely and quickly develops in spruce trees attacked by spruce bark beetles.

Besides economic effects, heart rot fungi appear to be the primary disturbance agents that drive the canopy-gap process of disturbance in many old forests. They are vital agents that alter forest structure and succession, and directly enhance wildlife habitat. Specific heart rot levels can be achieved in managed forests by controlling the frequency and size of bole wounds during stand entries. Studies on the ecological roles of heart rot and the rate of wood decay in wounded trees continue.

Laminated root rot,
Phellinus weirii

Region 1: Idaho, Montana

Host(s): Douglas-fir, grand fir

Laminated root disease is very severe on parts of the Lolo, and Kootenai National Forests in Montana, as well as the Idaho Panhandle National Forests. Damage from laminated root disease has increased in recent years. This is attributed, in part, to the loss of root disease-tolerant western white pine to blister rust; an increase in Douglas-fir and true firs as a result of fire control; and selective harvesting of high-value, root disease-tolerant pine and western larch early in the 20th century.

Region 5: Northwestern California

Host(s): Douglas fir, white fir, and other conifers

Laminated root rot is limited to a few areas in Northern California in the Klamath Mountains. New infections killing white fir were found between previously known centers in southwest Oregon and a southern infection on the Scott River District in California.

Region 6: Oregon, Washington

Host(s): Conifers

Laminated root rot was the most serious forest tree disease west of the Cascade Mountains in Washington and Oregon. Overall, an estimated 8 percent of the area with susceptible host species is affected in this portion of the region. Locally, 15 to 20 percent of an area may be affected. East of the Cascades, laminated root rot affects mixed conifer stands north of the Crooked River in central and northeastern Oregon and throughout eastern Washington. Effects of the disease include significant changes

in species composition, size, and structure. Regeneration of susceptible species in root disease centers may not grow beyond sapling and pole size. Hardwood trees and shrubs, which are immune to the fungus, often increase their site occupancy.

Oak wilt, *Ceratocystis fagacaerum*

Region 2: Kansas, Nebraska

Host(s): Oak species

A recurring disease; however, both States report a decline in activity.

Region 8: Arkansas, Kentucky, North Carolina, South Carolina, Tennessee, Texas, Virginia

Host(s): Oaks, mainly red oak group; live oaks in Texas

Oak wilt continues to be epidemic in central Texas. New detections have increased the number of affected counties to 61. A cooperative oak wilt suppression project with the State continues in central Texas. The U.S. Army Corps of Engineers is also initiating a suppression project adjacent to several lakes in central Texas.

North Carolina reports that in 1996, oak wilt intensified in the western part of the State, specifically in Haywood, Buncombe, Jackson, and Madison Counties. In other States, little new or serious disease activity was reported.

Region 9/Northeastern Area: Illinois, Indiana, Iowa, Minnesota, Missouri, Ohio, Pennsylvania, West Virginia, Wisconsin

Host(s): Black oak, red oak, white oak

The disease continued to affect trees in Illinois. The disease is still primarily a problem in the northwestern part of Indiana with scattered mortality throughout the area in the red oak forest type. In Iowa, oak wilt surveys showed over 4,000 acres affected in 1- to 3-acre pockets within the oak/hickory forests. In Minnesota, 7,200 acres of red oak mortality was reported. Oak wilt infection centers in Minnesota were treated with assistance from the Cooperative Suppression Program. Black oak and red oak were affected in Missouri, Ohio, and Pennsylvania. In West Virginia, aerial surveys detected infection sites in oak forests. In Wisconsin, surveys were conducted in sites along utility lines in urban and rural areas to monitor the spread of the disease.

Diseases: Nonnative

Beech bark disease,
Nectria coccinea
var. *faginata*

Region 8: North Carolina, Tennessee

Host(s): American beech

The first mortality reported in the Southern Region was in northern Virginia in the mid-1980's. Beech bark disease was first reported in the Great Smoky Mountains National Park in 1994. This introduction is well in advance of the previously known distribution. Distribution of the scale now includes Blount County, Tennessee, but mortality has not yet been detected. Increase in scale distribution and proliferation of *Nectria* mortality centers continued during 1996 in the three-county area of Swain, NC; Hayward, NC; and Sevier, TN.

Region 9/Northeastern Area: Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia

Host(s): American beech

In Massachusetts, 1,300 acres showing dieback and mortality were reported due to the disease in combination with drought from the previous year in Berkshire County. In Vermont, less damage was mapped by aerial survey than in previous years. Scale populations were also reported to be lower. In West Virginia, the beech component of forested areas covering 600,000 acres was reported affected in Pendleton, Pocahontas, Randolph, Tucker, and Upshur Counties. There was also about 950,000 acres of beech trees infested with beech scale but showing no apparent damage. The level of infested area was similar to 1995.

Dutch elm disease,
Ophiostoma (=*Ceratocystis*)
ulmi

Region 1: Idaho, Montana, North Dakota

Host(s): American elm

Dutch elm disease continued to spread in urban areas in North Dakota and Montana. Montana's highest losses are occurring in the cities of Billings and Great Falls. In North Dakota, heavy losses have occurred at the Knife River Indian Villages National Historic Site. In northern Idaho, it has been reported in Moscow where, in spite of an aggressive treatment program initiated several years ago, eight more elms were lost to the disease in 1996.

Region 2: Colorado, Kansas, Nebraska, South Dakota

Host(s): Elm species

In Colorado, Dutch elm disease is at static levels except for Walsenburg and Trinidad, Colorado, were slight increases were observed. Kansas and

Nebraska report static levels that represent serious problems in urban areas. In South Dakota, reports of Dutch elm disease increased, more reports and more communities reporting, than in 1995.

Region 8: Regionwide

Host(s): Elms, particularly American elm

Scattered to localized mortality continues to occur at generally low levels in urban and wild populations of elms.

Region 9/Northeastern Area: Areawide

Host(s): American elm, Siberian elm, slippery elm

Dutch elm disease (both *Ophiostoma ulmi* and a new strain, *O. novo-ulmi*) remains common to American elm throughout the Northeastern United States. In Iowa, both large and small sawtimber size trees were affected on over 1,600 acres, up from the 1,240 acres affected in 1995.

White pine blister rust, *Cronartium ribicola*

Region 1: Idaho, Montana

Host(s): Western white pine, whitebark pine

White pine blister rust causes extensive tree mortality throughout the range of western white pine. Mortality of naturally occurring regeneration has virtually eliminated western white pine from many forests, resulting in a major transition in forest types. Restoration efforts are concentrating on planting genetically improved, rust-resistant stock. In addition, pruning branches of natural regeneration is being done to improve survival in some areas. Blister rust is also causing extensive mortality in high-elevation five-needle pines. Recent surveys have found infection rates in whitebark pine regeneration of up to 90 percent. There is a growing concern that severe losses of whitebark pine may have significant impacts on water and wildlife in these fragile ecosystems.

Region 2: Colorado, Wyoming

Host(s): Limber pine, white pine

In Wyoming, all areas with five-needle pines are known to be infected with white pine blister rust. Some branch and tree mortality in limber pine is occurring on Casper Mountain and northwest of Cody, in the Sunlight area, on the Shoshone National Forest.

Region 3: New Mexico

Host(s): Southwestern white pine

White pine blister rust occurs throughout most of the range of southwestern white pine (*Pinus strobiformis*) in the Sacramento Mountains, White Mountains, and Capitan Mountains of southern New Mexico. Roughly 500,000 acres are affected. This disease has not been found in Arizona.

Region 4: Idaho, Nevada

Host(s): Limber pine, whitebark pine

A formal survey of five-needle pines was conducted in 1995-1996 to quantify disease incidence and intensity, and determine site and stand characteristics of infected areas. An interim report is forthcoming.

Region 5: California

Host(s): Sugar pine, Western white pine, whitebark pine

Throughout the Sierra Nevada and Coast Ranges, white pine blister rust is causing branch flagging and mortality of sugar pine and other white pines. Blister rust was found attacking previously resistant sugar pine saplings in two separate test plantings at Mountain Home Demonstration State Forest in the southern Sierra Nevadas. The second California site where sugar pine genotypes with major gene resistance (MGR) are being attacked is near Happy Camp in Siskiyou County. It is not known if the Mountain Home Strain is the same fungal strain as the one at Happy Camp.

Region 6: Oregon, Washington

Host(s): Western white pine, sugar pine, whitebark pine

White pine blister rust, in combination with mountain pine beetle, is killing many host trees. Of particular concern are the effects of blister rust in whitebark pine at high elevations in the Cascades and in the Blue and Wallowa Mountains, where survey and impact data are not available.

An attempt was made to aerially identify areas symptomatic of blister rust beginning in 1994. Although blister rust is known to occur extensively throughout the range of susceptible host type, observers mapped only 4,700 acres in Washington in 1996. Blister rust symptoms are difficult to distinguish from the more easily observed effects of mountain pine beetle. The bulk of the reported acreage fell within the Yakama Indian Reservation and the Gifford Pinchot, Okanogan, and Wenatchee National Forests.

Diseases: Origin unknown

Butternut canker,
Sirococcus clavigigenti juglandacearam

Region 8: Alabama, Arkansas, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, Virginia

Host(s): Butternut (white walnut)

This disease has been in the South for at least 40 years, and is estimated to have killed 77 percent of the trees in North Carolina and Virginia. The fungus kills large trees, saplings, and regeneration. The USDA Forest Service placed a moratorium on the harvesting of healthy butternut trees on National Forest System lands. Trees exhibiting resistance were found in North Carolina, Kentucky, Arkansas, and Virginia. A cove with a large number of canker-free and cankered trees was located in western North Carolina and was turned into a seed collection area. All potentially resistant trees are being propagated by grafting and nut collection for host resistance studies. Butternut canker is projected to spread and kill most of the species, including regeneration. Butternut will be replaced by other species on these sites. It is too early to project the success of selection and breeding in producing resistant stock.

Region 9/Northeastern Area: Areawide

Host(s): Butternut

In Maine, the disease occurred in all counties and the incidence increased. Several States were surveyed for uninfected trees from which to take cuttings for propagation. In Vermont, the disease remained a common cause of butternut mortality, but trees without cankers were occasionally observed in heavily infected stands.

Dogwood anthracnose,
Discula destructiva

Region 8: Alabama, Georgia, Kentucky, North Carolina, South Carolina, Tennessee, Virginia

Host(s): Flowering dogwood

Dogwood anthracnose was first identified in the South in 1987, with the report of 30,000 acres affected in the Cohutta Wilderness in northern Georgia. Surveys and impact plots across the 7 affected southern States have now identified 237 counties impacted by this disease. Dogwood anthracnose is primarily found in the mountains, foothills, and upper Piedmont. Damage is most severe in the forest environment at higher elevations and in cool moist areas in the lower elevations.

Diseases: Origin unknown

Region 9/Northeastern Area: Connecticut, District of Columbia, Indiana, Maine, Maryland, Massachusetts, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, West Virginia

Host(s): Flowering dogwood

Dogwood anthracnose was first found in southeastern New York in 1978. Diseased dogwoods have now been found in 14 of the 20 northeastern States and the District of Columbia.

In 1996 the disease did not spread from the counties reported infected in 1995 in the 14 States and the District of Columbia, however, the incidence of the disease did increase within some of the affected areas due to wet spring weather.

Pitch canker, *Fusarium subglutinans*

Region 5: Coastal California

Host(s): Bishop pine, Douglas-fir, Monterey pine, Monterey x knobcone, other ornamental pines

Pine pitch canker continues to spread throughout coastal California and is now established in 17 counties. Extension of the disease within infested counties includes native Monterey pine at Point Lobos State Park; planted Monterey pine at Plaskett Creek Campground, Los Padres National Forest; and native Bishop pine near Diablo Canyon, San Luis Obispo County. The disease continues to spread and intensify within all three of California's native Monterey pine stands. A survey at Cambria found infected individual trees as well as groups of trees scattered throughout the native forest. Within these disease centers it was common to find seedlings killed by an infection at the soil line. At Ano Nuevo State Park, mortality was widespread. Infected Monterey pines are closely associated with native Douglas-fir, which do not show symptoms.

Port-Orford-cedar root disease, *Phytophthora lateralis*

Region 5: California

Host(s): Pacific yew, Port-Orford-cedar

Newly discovered infestations of Port-Orford-cedar root disease in the Klamath River basin and on the east side of the Sacramento River, south of Dunsmuir, expose a considerable amount of Port-Orford-cedar to increased likelihood of infection. The Sacramento River infestation is in a group of Port-Orford-cedars at the eastern and southern extent of the natural range of this species.

Region 6: Oregon

Host(s): Port-Orford-cedar

Port-Orford-cedar root disease causes mortality of Port-Orford-cedar in southwestern Oregon. Where it has been introduced, the disease causes extensive mortality on sites favorable for infection and spread of its waterborne spores, especially along creeks, in low-lying areas, and below roads where water is channeled.

Evidence of the disease was reported over a total of 21,000 acres in 1994. Within these areas, mortality was distributed in scattered pockets or individual trees. On National Forest System lands, slightly less than 10 percent of all Port-Orford-cedar is infected.

Declines and Complexes

Ash yellows/declines

Region 9/Northeastern Area: Iowa, New York, Ohio, Vermont, West Virginia

Host(s): Green ash, white ash

In Iowa, scattered individual groups of trees were infected, with about 3,000 trees affected statewide. In New York, the disease was widespread, and brooming and epicormic shoot symptoms were observed. No activity was reported in Ohio. In Vermont the disease remained common, but the increase was less than in previous years. There were also reports of brooming symptoms from several counties in West Virginia.

Aspen defoliator complex

Region 3: Arizona, New Mexico

Host(s): Aspen

Aspen defoliation caused by this complex of insects and diseases—including large aspen tortrix (*Choristoneura conflictana*), western tent caterpillar (*Malacosoma californicum*), and marssonina leaf blight (*Marssonina populi*)—and abiotic factors increased region-wide from 14,240 acres in 1995 to 35,650 acres in 1996. Defoliation on Federal lands in Arizona included the Apache-Sitgreaves National Forest (1,735 acres), Coconino National Forest (5,300 acres), Coronado National Forest (10 acres), Kaibab National Forest (2,595 acres), Tonto National Forest (40 acres), Grand Canyon National Park (310 acres), and the Navajo Indian Reservation (90 acres). In New Mexico, aspen defoliation caused by this complex totaled 25,570 acres. Defoliation occurred on the Carson National Forest (10,185 acres), Cibola National Forest (2,080 acres), Lincoln National Forest (960 acres), Santa Fe National Forest (5,550 acres), Santa Clara Pueblo Indian Reservation (120 acres), and Mescalero Apache Indian Reservation (280 acres). In addition, approximately 6,395 acres of aspen defoliation were reported on State and private lands in Colfax, Rio Arriba, Cibola, Sandoval, and Taos Counties.

Region 9/Northeastern Area: Minnesota

Host(s): Aspen, quaking aspen

In Minnesota, defoliation from this complex reached a peak of over 600,000 acres in 1994 and declined significantly in 1995 to less than 37,000 acres. No significant activity was reported in 1996.

Brown ash decline

Region 9/Northeastern Area: Maine

Host(s): Black ash

In Maine, the tree condition of black (locally called brown) ash improved in 1996 after several years of severe dieback and decline. Also, crowns showed much improvement from 1992 and 1993 conditions and the trend was expected to continue. The initial decline was attributed to abiotic conditions: fall flooding and freezing.

Multiple stressors

Region 9/Northeastern Area: Maine

Host(s): American beech, red maple, yellow birch

Since 1994, approximately 180,000 acres in Maine in Aroostook, Penobscot, Picataquis, and Somerset counties experienced dieback and decline of hardwoods. The dieback and decline did not expand or intensify significantly in 1996. American beech has been especially affected due to variable oakleaf caterpillar, oystershell scale, and drought conditions in 1995.

Native insect complex

Region 9/Northeastern Area: Pennsylvania

Host(s): Black cherry, maples, oaks

This complex is made up of elm spanworm, fall cankerworm, forest tent caterpillar, and/or eastern tent caterpillar. Populations dropped dramatically in Pennsylvania in 1996, where there were only 1,122 acres of defoliation, down from 650,000 in 1995. About 28,000 acres of the infestation area were sprayed in 1995.

Oak decline

Region 8: Regionwide

Host(s): Oaks, hickories, and associated hardwoods

Oak decline is a syndrome resulting in dieback and mortality of dominant and codominant mature oaks. Causal factors are stressors such as drought, frost, defoliation by insects, and secondary agents such as *Armillaria* root disease and twolined chestnut borer (*Agrilus bilineatus*). Host age and site conditions also play a role. Data analysis of forest inventory data in 12 southern States indicates an estimated 3.9 million acres of upland hardwood forest are affected by oak decline—about 9.9 percent of the susceptible host type. Average annual mortality volume of oaks on affected sites was 45 percent higher than on unaffected areas. Some of the oak decline reported here is located in areas heavily defoliated by the gypsy moth. Oak decline and gypsy moth interact: pre-existing oak decline increases mortality after gypsy moth defoliation. Also, severe defoliation

can induce oak decline in previously asymptomatic areas. No local or widespread severe decline were reported during 1996.

Subalpine fir mortality complex

Region 1: Idaho, Montana

Host(s): Subalpine fir

Western balsam bark beetle populations once again caused significant amounts of mortality in high-elevation subalpine fir stands on several forests in the region, in 1996. Infested area increased slightly from the 49,000 acres recorded in 1995, to more than 53,500 acres in 1996. Perhaps only one of a complex of pests responsible for reported mortality, which likely includes root diseases and other secondary bark beetles, western balsam bark beetle is the most conspicuous and most aggressive of the complex. It is quite capable of killing its host in the absence of other pests. Of the infested area recorded, nearly 9,000 acres were in northern Idaho, principally on the Idaho Panhandle and Nez Perce National Forests. The remaining 44,600 acres were in western Montana; most on the Beaverhead and Gallatin National Forests. An estimated 51,000 subalpine firs were killed, regionwide, in 1995 (recorded in 1996).

Region 2: Colorado, Wyoming

Host(S): Subalpine fir

Mortality was common throughout the spruce/fir cover type from the Wyoming-Colorado border south throughout the Rocky Mountains. Western balsam bark beetle (*Dryocetes confusus*) and additional factors, especially armillaria root disease and possible other biotic and abiotic components, are acting together to produce this mortality. The area from Centennial, Wyoming, to Grand Junction and Leadville, Colorado, has especially concentrated areas of mortality. Aerial survey of 86 percent of Colorado documented 327,993 dead subalpine fir on 147,244 acres. Efforts are underway to determine the causes, effects, and mitigation measures possible to deal with this mortality complex. Mortality was common on both the Shoshone and Bighorn National Forests in Wyoming. Over 12,500 trees on 7,000 acres were affected on National Forest System, other Federal, State, and privately owned lands in the vicinity of the Shoshone National Forest. Mortality was common throughout the spruce/fir cover type in Wyoming.

Region 4: Idaho, Utah, Wyoming

Host(s): Subalpine fir

During the years 1988-1994, subalpine fir mortality in this region has been mostly attributed to the western balsam bark beetle (*Dryocetes confusus*). However, ground examinations in 1995 suggest a complex of factors are involved in this mortality. These factors include: twig beetles, secondary bark beetles, wood borers, engraver beetles, root diseases, cankers, rusts (including *Dryocetes confusus*, *Pityophthorus* sp., *Pityokeines* sp., *Crypturgus* sp., *Scolytus* sp., *Heterobasidion annosum*, *Armillaria* sp.,

Cytospora abietis, and *Melampsorella caryophyllacearum*), and environmental conditions.

This complex has resulted in the death of 121,175 trees throughout the region. Even though this mortality complex is the most widespread cause of visible mortality in the region, its incidence is declining. In Idaho, 38,200 trees were killed during 1996 compared to 78,000 trees in 1995. Large areas of mortality are located on all forests in southern Idaho. In Utah, activity decreased with only 52,500 trees killed in 1996. Mortality was observed on every forest in Utah. Activity also decreased in western Wyoming with 54,000 trees killed in 1996 compared to 72,300 trees in 1995.

Yellow-cedar decline

Region 10: Alaska

Host(s): Yellow-cedar

Decline and mortality of yellow-cedar persists in Alaska. About 595,000 acres of decline have been mapped during aerial surveys. Concentrated mortality occurs in a wide band from western Chichagof and Baranof Islands to the Ketchikan area primarily on National Forest System lands (563,400 acres). All research suggests that some site condition, probably associated with poorly drained anaerobic soils, is responsible for initiating and continuing cedar decline. The intense canopy mortality causes change in forest structure, composition, and succession.

Seed Orchard Insects and Diseases

Coneworms,
Dioryctria amatella
Dioryctria clarioralis
Dioryctria disclusa
Dioryctria merkeli

Region 8: Regionwide

Host(s): Loblolly pine, longleaf pine, slash pine, shortleaf pine

Coneworms continued to cause damage in seed orchards across the South. Data from the Southwide Coneworm Survey showed large populations of the webbing coneworm (*Dioryctria disclusa*) in the Atlantic Coast States. This species was trapped in large numbers in June in orchards in South Carolina. The southern pine coneworm (*D. amatella*) and the loblolly pine coneworm (*D. merkeli*) occurred in large numbers in October in orchards in Texas, Mississippi, and Georgia. Additionally, first-generation southern pine coneworm occurred in significant numbers in Texas. Coneworm damage significantly reduced the survival of loblolly, longleaf, shortleaf, and slash in untreated sources on Federal seed orchards in Arkansas, Louisiana, and Mississippi.

Filbertworm,
Cydia latiferreana
Acorn weevils,
Curculio spp.
Conotrachelus spp.
Acorn worm,
Valentinia glandulella
Gall wasps,
Cynipoidea

Region 8: Arkansas

Host(s): White oak

On monitored research plots on the Ouachita and Ozark National Forests, these insects are responsible for substantial destruction of the white oak acorn crop. The acorn weevils and the filbertworm are the primary pests of white oak in the areas studied. In 1995, acorn weevils were responsible for approximately 20 percent of damaged and destroyed acorns in the research areas.

Filbertworm,
Cydia latiferreana
Acorn weevil,
Curculio spp.
Conotrachelus spp.
Pip gall wasp,
Callirhytis operator
Carpenterworm,
Prionxystus robiniae
Scale,
Eriococcid spp.
Stone gall,
Callirhytis fructuosa

Region 8: Tennessee

Hosts: Northern red oak

At the Northern Red Oak Seed Orchard in Tennessee, an outbreak of scale (*Eriococcid* spp.) has affected over 50 percent of the orchard trees in 1995. However, an unidentified ladybird beetle (*Scymus* sp.) began attacking the scales in late 1995 and by the end of the 1996 growing season, most trees in the orchard were scale free. Trees that were infested in 1995 failed to produce acorns in 1996, thus the harvest in the fall of 1996 was very small compared to the previous 5 years. Acorn weevils caused extensive late season damage in 1996. The damage was estimated to exceed 25 percent of the remaining acron crop at harvest. The incidence of damage from filbertworm, stone gall, and pip gall wasp was low in 1996.

Pitch canker,
Fusarium subglutinans

Region 8: Florida

Host(s): Slash pine

The 1994-5 flare up of this insect/disease complex in seed orchards has stabilized. No significant activity occurred in 1996.

Seed bugs,
Leptoglossus corculus
Tetyra bipunctata

Region 8: Regionwide

Host(s): Loblolly pine, longleaf pine, slash pine, shortleaf pine

Seed bugs continued to cause damage on loblolly, longleaf, shortleaf, and slash pine orchard trees throughout the South. On monitored orchards in Louisiana and Mississippi, these insects accounted for confirmed losses of 2 to 28 percent of seed harvested. These percentages likely underestimate seed bug losses because many empty seeds observed in radiographs of seed may also result from seed bug feeding during development of the cones.

Additionally, seed bugs cause significant loss due to conelet abortion, especially in longleaf pine.

Southern cone rust, *Cronartium strobilinum*

Region 8: Alabama, Florida, Georgia

Host(s): Longleaf pine, slash pine

The recent upsurge in infection of slash and longleaf pine cones caused by southern cone rust has apparently subsided, although cone and seed lossess in the Florida Division of Forestry's Withlacoochee Seed Orchard at Brooksville were still approximately 20 percent. Aerial fungicide application shows promise as a control.

Western conifer seed bug, *Leptoglossus occidentalis*
Cone beetle, *Conophthorus ponderosae*
Coneworm, *Dioryctria abietivorella*

Region 1: Idaho, Montana

Host(s): Conifers

Cone and seed insects are very significant in the region's blister rust-resistant western white pine seed orchards. They are also a concern in orchards of other tree species and in wild stands where seed of high quality trees is collected. Cone and seed insects have recently been found having an impact on the seed of whitebark pine, an important high elevation tree species. The insects causing the most damage are the western conifer seed bug (*Leptoglossus occidentalis*), the cone beetle (*Conophthorus ponderosae*), and the coneworm (*Dioryctria abietivorella*). Cone beetle populations were so high in the Coeur d'Alene white pine seed orchard in 1996 that an early insecticidal spray treatment is planned for April of 1997. Annual mid-summer spray treatments to control seed bugs have occurred in that orchard for the past several years.

White pine cone beetle, *Conopthorus coniperda*

Region 8: Tennessee, North Carolina

Host(s): Eastern white pine

Overwintering white pine cone beetle populations more than doubled over 1995 levels at the Forest Service Beech Creek Seed Orchard near Murphy, North Carolina. On three Tennessee Division of Forestry orchards popu-

lations declined. This compares with declining beetle populations on the North Carolina Forest Service orchard near Morganton.

Nursery Insects and Diseases

Black vine weevil, *Otiorhynchus sulcatus*

Region 5: Northern California

Host(s): Douglas-fir, red fir

High populations of black vine weevil larvae destroyed 750,000 Douglas-fir seedlings in the Humboldt Nursery in McKinleyville. The adults migrated to and fed on a bed of alder seedlings destroying at least 100 feet of seedlings before treatment with orthene.

Charcoal root disease, *Macrophomina phaseolina*

Region 5: California

Host(s): Douglas-fir, giant sequoia, pinyon pine, red fir, sugar pine, white fir,

Charcoal root rot killed approximately 15 percent of the 2+0 red fir crop at Placerville Nursery. Douglas-fir, red fir, white fir, sugar pine, pinyon pine, and giant sequoia 1+0 seedlings are also affected with between 5 and 50 percent mortality in various seedlots. Three years ago the nursery discontinued fumigating with methyl bromide + chloropicrin, which has allowed a build-up of microsclerotia in the soil.

Cranberry girdler moth, *Chrysoteuchia topiaria*

Region 1: Idaho, Montana

Host(s): Conifers

The cranberry girdler moth has been a continuous problem in the Coeur d'Alene bareroot nursery as insect populations immigrate from surrounding grass fields. The larvae damage root crowns of Douglas-fir, western larch, and spruce bareroot seedlings. Insecticidal sprays were used to control the moths in 1996.

Damping-off,
***Fusarium* spp.**
***Pythium* spp.**

Region 6: Oregon, Washington

Host(s): Conifers

The nurseries experienced approximately 5-percent mortality to damping-off. Fumigation, deep watering, and delayed fertilization helped control damping-off.

Region 8: Regionwide

Host(s): Southern pines

Damping-off is the most common disease problem that faces southern nurseries. The loss of seedlings to damping-off is highly variable from year to year, due to the interaction of pathogenic fungi (species of *Fusarium*, *Pythium*, *Rhizoctonia*, and *Phytophthora*) and environmental conditions. Seedling losses can be severe when germination of seedlings is slow due to cold, wet weather. In 1996, over 500,000 container longleaf pine seedlings were lost to damping-off in one Georgia nursery.

Fusarium root disease,
***Fusarium* spp.**

Region 1: Idaho, Montana

Host(s): Conifers

The most common and damaging diseases of conifer seedlings in nurseries in the region in 1996 were root diseases caused by *Fusarium* spp. These fungi cause damping-off and root diseases on many different conifer hosts in bareroot and container nurseries. The most common soil-borne pathogen species in bareroot nurseries is *F. oxysporum*, although several other species of potential pathogenicity are also commonly isolated from infested soil and diseased seedlings. The major pathogen in container nurseries is *F. proliferatum*, although *F. oxysporum* and several other fusaria occur at high levels in some nurseries. Although all conifer species are susceptible, most damage occurs on Douglas-fir, western larch, western white pine, and Engelmann spruce.

Region 4: Idaho, Utah

Host(s): Douglas-fir, ponderosa pine, spruce, true firs

Fusarium oxysporum causes small amounts of mortality primarily of 1+0 conifer seedlings at the Lucky Peak Nursery, Boise National Forest, Idaho, and the Lone Peak Nursery in Utah.

Region 6: Oregon, Washington

Host(s): Conifers

The nurseries experienced 4 to 6 percent mortality due to fusarium root disease and hypocotyl rot, *Fusarium* spp., infections during the 1+0 year. Cooling by irrigation helped to limit losses.

Gray mold, *Botrytis cinerea*

Region 1: Idaho, Montana

Host(s): Conifers

Botrytis cinerea is prevalent on nursery seedlings at several locations and causes high levels of damage to container-grown western redcedar and western larch seedlings. Damage to other conifer species also occurred, but root decay of five-needle pines was most serious.

Lygus bug, *Lygus* spp.

Region 8: Florida, South Carolina

Host(s): Conifers

Seedling damage from lygus bug feeding resulted in the loss of 250,000 sand pine seedlings in a Florida nursery and 75,000 loblolly pine in a South Carolina nursery.

Pythium root rot, *Pythium* spp.

Region 1: Idaho, Montana

Host(s): Conifers

Pythium root disease (mostly caused by *Pythium ultimum*) occurred at most bareroot nurseries and was also found in container seedlings. Damage was usually minor and mitigated by improving water drainage in soil and container media. Recent efforts to find alternatives to methyl bromide soil fumigation in production of bareroot stock have indicated that following nursery fields with periodic tilling for at least one growing season prior to planting conifer seeds helps reduce soil pathogen levels so that high-quality seedlings often can be produced without fumigation. Incorporating cover and green manure crops prior to sowing often increases soil pathogens and reduces seedling production and quality.

Region 4: Idaho, Utah

Host(s): Douglas-fir, spruce

Pythium root rot along with phytophthora root rot (caused by *Phytophthora* spp.) occur infrequently on seedlings and in soil at the Lucky Peak Nursery, Boise National Forest, Idaho, and the Lone Peak Nursery in Utah. Infection results in patch mortality and culling of 2+0 seedlings.

Region 8: Mississippi

Host(s): Loblolly pine

Approximately 35,000 seedlings were lost in one nursery in 1996.

Rhizoctonia needle blight,
***Rhizoctonia* spp.**

Region 8: Florida, South Carolina

Host(s): Conifers

Rhizoctonia needle blight caused the loss of 200,000 longleaf pine seedlings in a South Carolina nursery and 50,000 longleaf pine in a Florida nursery.

Tip dieback,
Sirococcus strobilinus
Sphaeropsis sapinea
Phoma eupyrena

Region 1: Idaho, Montana

Host(s): Conifers

Tip dieback occurred at several nurseries on bareroot pine seedlings. Ponderosa pine and lodgepole pine were the most commonly affected species.

Abiotic Damage

Air pollution

Region 5: California

Host(s): Jeffrey and ponderosa pine

Ozone damage levels decreased slightly since 1994 based on data from 27 ozone injury monitoring plots on the Sequoia National Forest. The plots were equally divided among three categories of change; nine showed increased injury, nine decreased injury and nine remained unchanged.

Region 8: Regionwide

Host(s): Eastern white pine and various bioindicator species

Ozone-caused tipburn was observed on eastern white pine throughout the South. Bioindicator plants were used to assess ozone levels in Class I wilderness areas in North Carolina and Georgia. The Class I wildernesses are surveyed on an annual basis and results are compiled and displayed in tabular format with interpretation as Field Office reports. The reports are used by air resource specialists as tools in permit evaluation. There were slight differences between data collected in 1996 compared to 1995. However, Tennessee reports significantly less ozone damage on white pines on higher elevation sites on the Cumberland plateau in 1996.

Region 9/Northeastern Area: New Hampshire

Host(s): Eastern white pine

New Hampshire reported 30,000 acres of damage to trees along the Merimack River Valley thought to be caused by sulpher dioxide. Discoloration of many eastern white pine was moderate to heavy. An unusually high number of days with fog may have contributed to the damage by holding the pollutant down in the valley.

Drought effects

Region: 3 Arizona

Host(s): All species

Drought damage was detected on 61,130 acres in Arizona in 1996. Most species were affected with symptoms that ranged from yellowed or dried foliage to foliage loss. The following areas had acreages recorded as sustaining drought damage: the Apache-Sitgreaves National Forest (310 acres), Coconino National Forest (4,980 acres), Coronado National Forest (3,065 acres), Grand Canyon National Park (700 acres), Kaibab National Forest (24,615 acres), Tonto National Forest (270 acres), and the Hualupai Indian Reservation (27,190 acres).

Region 5: California

Host(s): Conifers, some hardwoods

Conifer mortality due to drought-induced moisture stress followed by bark beetle attack continued in northern California. However, the damage trend is down from recent years.

Region 9/Northeastern Area: Maine, Massachusetts, New York, Missouri, Vermont

Host(s): American beech, sugar maple, northern red oak, other hardwoods, and white pine.

In 1996, areas of beech in northwestern Maine showed deteriorating crowns as a result of several factors, including the drought conditions in 1995. Most of the affected stands were on ridgetops. In Massachusetts, red oak and beech mortality was observed on ledgey hillsides. White pine mortality was reported in eastern New York. In Missouri, various hardwoods were affected. Leaf curling was observed in scattered locations in Vermont, partly a result of dry conditions in 1995.

Flooding/high water

Region 9/Northeastern Area: Iowa, Indiana, Minnesota, Vermont

Host(s): Various hardwoods

Heavy late spring and early summer rains caused flooding for 2 to 4 weeks in Iowa, affecting 1,200 acres statewide. In Indiana, bottomland sites suffered mortality from high water and flooding in the spring of 1996. In Minnesota, 3,300 acres of black ash were affected. Over 9,000 acres in Vermont were reported affected by flooding.

Ice Damage

Region 1: Idaho

Host(s): All species

On November 19, 1996, a severe winter storm passed through northern Idaho, producing freezing rain in lower elevations and heavy snow at higher elevations. The ice buildup caused millions of dollars of losses in urban areas as trees and power poles were broken and uprooted in a 30-mile swath from Spokane, Washington, to Wallace, Idaho.

Although complete assessments of losses in the forest will not be known until next spring, preliminary evaluations have estimated 10 to 20 million board feet of timber have been affected. Park and recreation areas along Lake Coeur d'Alene have been severely damaged; nearly 300,000 board feet are being salvaged from 80 acres of Tubb's Hill, a park managed as a natural area in downtown Coeur d'Alene. The ice was followed by several unusually wet snow storms that caused many roofs to collapse in several northern Idaho communities and also caused additional storm damage in forests throughout the region.

Abiotic Damage

Region 8: Louisiana

Host(s): All species

Branch breakage and toppling were common in central Louisiana in February when a severe ice storm coated trees with about 1/2 to 3/4 of an inch of ice.

Weather damage

Region 1: Idaho, Montana

Host(s): All spesies

Forest environments in this region are constantly being changed by natural forces such as high winds, fire, drought, and above-normal precipitation. Recent record heavy snow, wind, rain, and ice have caused severe to scattered damage throught the region. Preliminary indications are that these weather events have broken limbs, tops, and uprooted trees over many thouands of acres. Experience has shown that following such events, forest managers can expect forest insect populations to increase in most tree species. These populations are likely to infest the damaged trees in the spring of 1997, and cause tree mortality in 1998 and beyond.

Region 4: Idaho

Host(s): All vegetation

Temperatures as low as 19 °F on the nights of June 18 to 20 resulted in leader and branch tip mortality to tender emerging new growth throughout central and eastern Idaho.

Region 5: Northern California

Host(s): Firs, oaks, pines

Storm damage from heavy, wet snows and high winds was extensive throughout much of northern California. Extensive breakage and blowdown occurred on the Klamath, Modoc, Lassen, Plumas, and Tahoe National Forests. The total volume of blowdown is estimated at over 70 million board feet.

Wind damage

Region 8: North Carolina, Virginia

Host(s): Several species

Hurricanes Bertha (July 12) and Fran (September 5) caused severe forest damage along the Southeast coast and inland throughout the piedmont and mountain foothills in 1996. In both cases, North Carolina was especially hard hit and it is difficult to tally losses attributable to each separately. The North Carolina Division of Forest Resources (NCDFR) and the USDA Forest Service report that Fran and Bertha affected 52 North Carolina counties, with heaviest losses occurring in Pender and New Hanover counties in the southern coastal plain. NCDRF estimates that these two storms caused the loss of 14.5 million cords of pulpwood

and nearly 8.7 million board feet of sawtimber, collectively valued at $1.3 billion.

Damage by Fran and Bertha was less severe in Virginia, but nonetheless significant. Virginia losses were concentrated in the central and northern Blue Ridge Mountains where hardwoods were badly damaged. There was also noteworthy damage in riparian areas, especially in the Shenandoah Valley.

There may be additional hurricane-related losses in 1997, owing to the stressed condition of the broken and flooded stands.

Region 9/Northeastern Area: Indiana, Minnesota, New Hampshire, New York, Pennsylvania, Vermont

Host(s): Various hardwoods and softwoods

Significant windstorms occurred at different times within the affected States causing blowdown and broken crowns. The damage was scatted and isolated, totaling about 1,500 acres in the Northeast.